CONTRACT DOCUMENTS

I-5 PUMP STATION AND FORCE MAIN UPGRADES

FOR

City of Woodburn

Volume 2 of 3

JULY 2021

City of Woodburn
Engineering Department
190 Garfield St
Woodburn, Oregon 97071

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FOR
I-5 PUMP STATION AND FORCE MAIN UPGRADES
FOR
CITY OF WOODBURN
PROJECT NO. 2018-012-11
BID NO. 2021-05

Division 44 through Division 46
NOT USED

VOLUME 3 OF 3

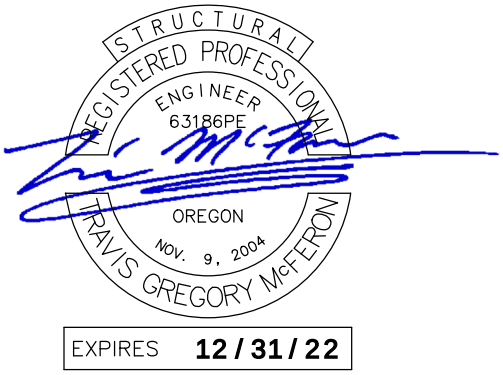
DRAWINGS
See Sheet G-1 for Drawing Index

END OF SECTION

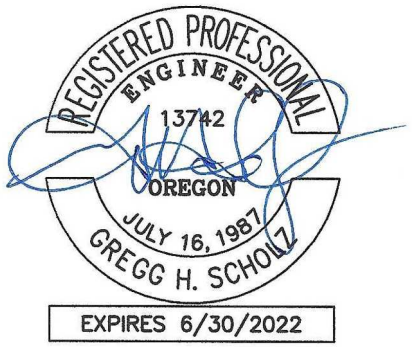
PROFESSIONAL OF RECORD CERTIFICATION(S):

	Signing as the Professional of Record for the divisions and sections listed below: Divisions 01, 05, 07, 08, 09, 10, 11, 22, 23, 31, 32, 33, 41, 43 Sections 02 30 00, 02 41 00, 40 05 13, 40 05 23.72, 40 05 51, 40 05 51.24, 40 05 61, 40 05 62, 40 94 23

PROFESSIONAL OF RECORD CERTIFICATION(S):

	Signing as the Professional of Record for the divisions and sections listed below: Division 03, 04, 06 Section 02 35 00

PROFESSIONAL OF RECORD CERTIFICATION(S):

 2021.07.01 13:20:07-07'00'	Signing as the Professional of Record for the divisions and sections listed below: Division 26 Section 40 60 00

SECTION 26 05 00 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. Furnish all labor, equipment, appliances, materials, transportation, facilities, services, tools and other equipment, and skilled supervision necessary for the construction, erection, installation, connection, testing, and adjustment of all circuits and electrical equipment specified herein, shown, or noted on the drawings; specified or required in other portions of this specification; and its delivery to the job site complete in all respects and ready for use.

C. The Contractor shall be responsible for the provision of equipment including all enclosures, disconnects, generators, transfer switches, MCC's, package systems, panelboards, lights, receptacles, and the like, unless otherwise specified. In addition, the Contractor shall be responsible for the following:

1. Visit the site of proposed construction. Verify and inspect the existing site to determine all conditions that affect this work.

2. Investigate and be apprised of the applicable codes, rules, and regulations as enforced by Authorities Having Jurisdiction (AHJs).

3. Use this Specification as a guide for workmanship and materials of construction.

D. Costs/charges for installation of all permanent and temporary facilities shall be included in the lump sum bid for the appropriate facility. This includes any up-front money required by the utility to provide permanent service.

E. Electrical Contractor installs and terminates wiring for I&C system, unless otherwise indicated.

1.2 INTENT OF DRAWINGS AND SPECIFICATIONS

A. Drawings and specifications are complimentary; what is called for by one shall be as binding as if called for by both. The Drawings govern in matters of quantity, the Specification in matters of quality. In event of conflict on Drawings or in the Specifications, the greater quantity and the higher quality apply.

B. Electrical drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.

C. Riser and other diagrams are schematic only and shall not be used for obtaining quantities.

D. The electrical drawings do not show complete details of the site conditions. The Contractor shall verify actual conditions at the project site, prior to ordering items.

1.3 COORDINATION OF WORK

A. The Contractor shall plan his work in coordination with the power utility authorities and Plant Operations. The plant and pump station are to remain operational throughout all phases of construction.

B. The Contractor shall field verify all dimensions of equipment to be installed or provided by others or by this contract so that correct clearances and connections may be made between the work installed by the Contractor and equipment installed or provided by others:

1. Dimensions of electrical equipment are to be obtained prior to ordering to ensure equipment will fit in the designated space. If pre-ordered dimensions indicate equipment will not fit, Contractor shall coordinate with engineer for a solution before proceeding with equipment ordering. Should equipment be ordered without verifying dimensions and subsequently does not fit in the designated space, contractor shall coordinate with engineer for a solution, but all costs associated with the change shall be borne by the Contractor.

C. The Contractor shall arrange all conduit runs so that they do not interfere with duct work, structural members, etc.

D. All working measurements shall be taken from the sites, checked with those shown on the drawings, and if they conflict, reported to the Engineer at once, and before proceeding with the work. Should the Contractor fail to comply with this procedure, he shall alter his work at his own expense as directed by the Engineer.

E. No extra payments will be allowed where obstructions in the work of other trades, or work under this contract requires offsets to conduit runs.

F. The Contractor is responsible for all alterations in the work to accommodate equipment differing in dimensions or other characteristics (such as control wiring, in the case of VFDs or similar equipment) from that shown or specified.

1.4 DEPARTURES FROM CONTRACT DOCUMENTS

A. Submit to the Engineer, in writing, details of any proposed departures from these Contract Documents, and the reasons the departures are necessary. Submit such requests as soon as practicable and within 30 days after award of the Contract. Make no such departures without written approval of the Engineer.

B. Should the Electrical Documents indicate a condition conflicting with the governing codes and regulations, refrain from installing that portion of the work until clarified by Engineer.

1.5 SUPERVISION

A. The Contractor shall maintain adequate supervision of the work and shall have a responsible person in charge at the site during all times that work under this contract is in progress, or when necessary for coordination with other work.

1.6 CODES AND STANDARDS

A. All work and materials shall conform to the applicable current standards (standard rules, regulations, and specifications) of the National Electrical Code (NEC), National Electrical Safety Code (NESC), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers' Association (NEMA), American National Standards Institute (ANSI), Insulated Cable Engineers Association (ICEA), Occupational Safety and Health Administration Standards (OSHA), State and local electrical codes, and other specifically cited standards, as applicable. All materials, unless otherwise approved by local government authorities, shall bear the label of, or be listed by, a Nationally Recognized Testing Laboratory (NRTL); the Underwriters' Laboratory, Inc. (UL) is one such NRTL. Where conflicts exist between any of the above standards, the standard which is most stringent shall take precedence. Where the contract documents exceed minimum requirements, the contract documents take precedence.

B. Observe where applicable the prevailing rules and requirements of the National Fire Protection Association (NFPA), the State and local fire marshals' regulations, and standards pertaining to adequate protection and/or guarding of any moving parts or otherwise hazardous conditions.

C. Resolve at the Contractor's expense all conflicts with applicable standards and provide a complete installation of Electrical Work, approved in all respects. Certain methods and materials for the project may require special approval and it is the Contractor's responsibility to prepare and submit to all approving authorities additional clarifying details, test data, methods and materials as needed to secure the required approval and resolve conflicts.

1.7 WORKMANSHIP

A. All work shall be performed by personnel skilled in the particular trade. Workmanship shall conform to the standards of the NEC and the installation standards of the National Electrical Contractors’ Association (NECA).

B. The Engineer shall be the sole judge as to whether or not the finished work is satisfactory; and if in his judgment any material or equipment has not been properly installed or finished, the Contractor shall replace the material or equipment whenever

required and reinstall it in a manner entirely satisfactory to the Engineer without any increase in cost to the Owner.

1.8 PERMITS, FEES, AND SERVICE CHARGES

A. The Contractor shall obtain all electrical permits and pay all related fees. See Section 01 10 00, Summary of Work regarding permit responsibilities for this project.

1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. In accordance with provisions elsewhere in these Contract Documents, manufacturers' names and catalog numbers stated herein are intended to indicate the type and quality of equipment or materials desired.

B. Make requests for approval of alternates in writing to the Engineer during the submittal process (no requests for pre-bid approvals will be accepted). Provide sufficient material or data to allow evaluation of the proposed alternatives and determination of compliance with these Contract Documents. List any proposed deviations from these Contract Documents.

1.10 SUBMITTALS AFTER AWARD OF CONTRACT

A. General: All electronic (PDF) submittals (including O&M Manual submittals) shall use standard 8.5” x 11” page sizes for all non-drawing pages. Drawings and/or schematics may use 8.5” x 11”, 11” x 17”, or 22” x 34” sized pages, as applicable. All drawings/schematic must be legible on whatever page size is used. Any manufacturer supplied information that comes on sizes other than these shall be re-sized to meet these requirements. Contractor may use any means necessary to have the information re-sized, but all re-sized materials must be legible. Submittals which do not meet these requirements are subject to wholesale rejection.

B. The Contractor shall provide complete manufacturer's descriptive information and shop drawings for all equipment, material, and devices furnished under this Division, including certified outline drawings, arrangement drawings, elementary (schematic) diagrams, interconnection diagrams, and connection diagrams, in accordance with provisions in Section 01 33 00 of these Contract Documents. Provide the number of copies specified therein for the Engineer, Contractor, and Operation and Maintenance Manuals.

C. Manufacturer's standardized elementary diagrams shall not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.

D. Contractor shall check submittals for proper number of copies, adequate identification, correctness and compliance with Drawings and Specifications, and initial all copies indicating this has been done. Revise, change, and/or resubmit all submittal

information until acceptable to the Engineer. Obtain Engineer's acceptance before commencing fabrication or installation of any materials or equipment:

1. When a resubmittal is requested, resubmit only the indicated deficient portions of the submittal in question or where changes have been made to previously acceptable items. Resubmitting previously acceptable items slows the review process as all resubmitted material is (re)reviewed.

E. Review of submittal information by the Engineer shall not relieve the Contractor from responsibility for deviations from Drawings and Specifications unless he has requested and received written approval from the Engineer for specific deviations at time of submission. Review of submittal information shall not relieve the Contractor from responsibility for errors and omissions in shop drawings or literature.

F. Submittals shall be made in accordance with the schedule listed hereinafter. Provide certified shop drawings, literature, and requested samples showing items proposed for use, size, dimensions, capacity, special features required, schematic (elementary) control diagrams, equipment schedules, rough in, etc., as required by the Engineer for complete review and for installation. Use NEMA device designations and symbols for all electric circuit diagrams submitted. Make content of schematic (elementary) connection of interconnection diagrams in accordance with the latest edition of NEMA ICS.

G. Submittals shall be made on, but not necessarily limited to, the following items, as applicable:

1. Switchgear, Switchboards
2. Circuit breakers and enclosures
3. Transformers
4. Panelboards and circuit breakers
5. Motor Controls
6. Special control panels - outline and schematic drawings, descriptive information, component schedules
7. Wiring Devices, including Receptacles (120v duplex outlets; generator receptacles), switches, boxes, etc.
8. Special pull boxes and junction boxes
9. All conduit types used in project.
10. All conductor/wire types used in project.

H. Submit a listing of all nameplate data from actual motors provided after delivery to site.

I. Provide one copy of each final, fully-accepted submittal furnished complete in the appropriate sections of the Operation & Maintenance (O&M) Manuals. The final submittals included in the O&M Manuals shall be compiled, as may be required, from all submittals and resubmittals, with any and all corrections included. Do not include all iterations of the submittals in the O&M Manuals; provide only the final, complete, fully-corrected, and fully-accepted submittal.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT, COMMON REQUIREMENTS

A. Unless otherwise indicated, provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment listed by UL (or other acceptable NRTL), bearing their label wherever standards have been established by that agency.

B. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

C. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

D. Indicated brand names and catalog numbers are used to establish standards of performance and quality. The description of materials listed herein governs in the event that catalog numbers do not correspond to materials described herein.

2.2 EQUIPMENT FINISHES

A. Provide materials and equipment with manufacturers' standard finish system. Provide manufacturers' standard finish color, except where specific color is indicated.

2.3 PORTABLE OR DETACHABLE PARTS

A. The Contractor shall retain in his possession and shall be responsible for all portable and detachable parts or portions of installations such as fuses, key locks, adapters, blocking chips, and inserts until completion of his work.

B. These parts shall be delivered to the Engineer and an itemized receipt obtained. This receipt, together with 2 copies of the final inspection certificate, shall be attached to the Contractor's request for final payment.

C. All equipment shall be demonstrated to operate in accordance with the requirements of this specification and the manufacturer's recommendations.

2.4 RUBBER MATTING

A. Install rubber floor matting in electrical room in front of all power distribution equipment, motor controllers and control panel.

B. Corrugated non-slip rubber mat of high dielectric strength and long aging qualities. Mat size, minimum of 36 inches wide extending the entire length of each power panel and control panel. Comply with ASTM Specification D178.24. 10,000 Volt minimum dielectric strength, 3/16" thick.

2.5 ACCESSORIES

A. Include special features, finishes, accessories, and other requirements as described in the Contract Documents regardless of the item's listed catalog number.

B. Provide incidentals not specifically mentioned herein or noted on Drawings, but needed to complete the system or systems, in a safe and satisfactory working condition.

PART 3 EXECUTION

3.1 DEMOLITION

A. Contractor shall be responsible for loss or damage to the existing facilities caused by him or his workmen and shall be responsible for repairing or replacing such loss or damage.

B. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all electrical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

C. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

D. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner and the Engineer. The Contractor shall notify the Owner and the Engineer at least 2 weeks in advance in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise

approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount:

1. Contractor shall arrange for all required temporary power as may be required during service outages. See also Section 01 12 16 Work Sequence.

2. Where temporary generators are used for extended periods, contractor shall provide temporary circuits for battery charger and block heater, as required.

E. The Contractor shall modify, remove, or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals or dismantling shall be conducted in a manner as to produce maximum salvage.

F. The Contractor shall survey the project with the Owner before demolition begins and determine all materials which the Owner specifically chooses to have salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner and shall be delivered to such destination as directed by the Owner.

G. When items scheduled for salvaged are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged during construction operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost.

H. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed entirely, or as acceptable to the Engineer.

I. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Engineer.

3.2 INSTALLATION, COMMON REQUIREMENTS

A. Install materials and equipment in a workmanlike manner, utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.

B. Coordinate electrical work with work of other trades to avoid conflicts, errors, delays, and unnecessary interference with plant operations during construction.

C. Install electrical equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of the electrical equipment; examine the instructions thoroughly. When requirements of the installation instructions conflict with the Contract Documents, request clarification from Engineer prior to proceeding with the installation.

D. Do not install electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block the area passage's intended usage.

E. Provide any necessary backing required to properly support all fixtures and equipment installed under this contract.

3.3 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, provide protection for materials and equipment against loss or damage in accordance with provisions elsewhere in these Contract Documents. Protect everything from the effects of weather.

B. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions, and items containing electrical insulation, such as transformers, and conductors. Energize all space heaters furnished with equipment.

C. Following installation protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction. Energize all space heaters furnished with equipment.

3.4 CUTTING, PATCHING, AND FRAMING

A. The Contractor shall determine in advance the locations and sizes of all sleeves, chases, and openings necessary for the proper installation of his work.

B. Whenever practical, inserts or sleeves shall be installed prior to covering work. Cutting and patching shall be held to a minimum. All required holes in concrete construction shall be made with a core drill and patched with non-shrink grout.

C. Cutting, fitting, repairing, and finishing of carpentry work, metal work, or concrete work, and the like, which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors; and holes required to be cut in floors must be drilled without breaking out around the holes.

3.5 CLEANING AND TOUCHUP PAINTING

A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the color, consistency, and type of surface of the original finish.

3.6 FIELD QUALITY CONTROL

A. Load Balance: The Drawings and Specifications indicate connection of electrical loads and distribution equipment; however, after installation, if necessary, certain electrical loads may require re-connection to achieve a more equal current balance. Make re-connections as may be required.

B. Motor Rotation: After final service connections are made, check and correct, if necessary, the rotation of all motors. Coordinate rotation with the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor, verifying that rotation has been checked and corrected.

C. Inspection: All materials, equipment, and workmanship shall be subject to inspection at any time by the Engineer, or his representatives. Correct work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer.

D. Tests:

1. Carry out tests specified hereinafter and as indicated under individual items of materials and equipment specified in other sections.

2. During site evaluations by Engineer, provide an electrician with tools to remove and replace trims, covers, devices, and the like, so that a proper evaluation of the installation can be performed.

3. The Contractor shall furnish all labor, material, instruments, and tools to make all connections for testing of the electrical and instrumentation installation. All equipment shall be demonstrated as operating properly prior to the acceptance of the work. All protective devices shall be operative during testing of equipment.

4. General:

a. Perform the tests as described below. Upon completion of all tests, submit written test results in duplicate for approval by the Engineer prior to acceptance.

b. After visual inspection of joints and connections and the application of tape and other insulating materials, all sections of the entire wiring system shall be thoroughly tested for shorts and grounds. A log of results for each circuit shall be kept by the Contractor and presented to the Engineer.

c. Equipment shall be tested by operating all electric motors, relays, controls, switches, heaters, etc. sufficiently to demonstrate proper installation and electrical connections. Control and emergency conditions shall be artificially simulated where necessary for complete system or subsystem tests.

d. Insulation resistance measurements of each circuit shall be made with loads connected and contactors, if any, blocked closed to give complete circuits. Insulation resistance of complete circuit shall be measured from the circuit breaker load terminals with the breaker open. A log of complete results shall be prepared by the Contractor and presented to the Engineer. Values of resistance shall be 10 megaohms or greater.

5. Operations:

a. After the electrical system installation is completed and at such time as the Engineer may indicate, conduct an operating test for approval. Demonstrate that the equipment operates in accordance with the requirements of these Specifications and Drawings.

b. Perform the test in the presence of the Engineer or his authorized representative. Furnish all instruments and personnel required for the tests. The Owner will furnish the necessary electric power. System performance shall conform to the following criteria. Deviations, if any, shall be noted on the test reports with indication of corrective action taken or proposed:

1) Plus, or minus 2 percent maximum variation between nominal system voltage and average system voltage.

2) Plus, or minus 5 percent maximum variation from nominal system voltage for all load conditions.

3) Actual motor current on each ungrounded conductor at prevailing conditions shall be equal to or less than nameplate rated full load motor current at a service factor of 1.0.

4) One percent maximum voltage unbalance at full load defined as 100 times the maximum deviation from average voltage divided by the average voltage. (Balance system loads and cooperate with the serving utility company to achieve a balanced condition which is within the indicated limits.)

5) Plus, or minus 10 percent maximum variation between average phase current and individual phase current. Balance system loads to achieve a balanced condition which is within the indicated limits.

6) Insulation resistance shall be tested under normal climatic conditions and shall conform to the following:

a) Circuits of 600 volts or less shall have conductor insulation resistance as installed of not less than 10,000,000 ohms to ground.

6. Document tests and include in Closeout Documents.

3.7 TEST REPORTS

A. Submit dated "Electrical System Test Reports" indicating all tests performed and demonstrating conformance with the required system performance criteria. This test report shall include all voltage, current, and resistance test data of the electrical service, main feeders, panelboards, power transformers, and ground systems, as applicable.

3.8 FINAL CORRECTION

A. Promptly correct any failures or defects revealed by these tests as determined by the engineer. Re-conduct tests on these corrected items as directed by the engineer.

3.9 CLEANING

A. Remove dirt and debris caused by the execution of the electrical work.

B. Leave the entire electrical system installed under this Contract in clean, dust-free and proper working order.

C. Vacuum clean interiors of electrical equipment enclosures.

3.10 RECORD DRAWINGS

A. The Contractor shall maintain a neatly marked set of record drawings. Contract Drawings shall be marked with red indelible pencil to show all departures from original Drawings, underground cable, conduit, or duct runs dimensioned from established building lines, and all electrical work revisions. In addition, the locations of panels, field mounted instruments and panels, terminal boxes, junction boxes and any other materials included in this contract shall be shown. As built drawings shall be kept current with the work as it progresses and shall be subject to inspection by the Engineer at any time.

3.11 GUARANTEE

A. Materials, equipment, and workmanship shall be guaranteed in accordance with provisions in these Contract Documents.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. This section covers the work necessary to furnish and install complete conductor systems as specified herein, including but not necessarily limited to building wire and cable, instrumentation cables, communication cables, and wiring connectors and connections.

1.3 REFERENCES

A. NECA (National Electrical Contractors Association) - Standard of Installation.

B. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:

1. Stranded copper conductor for services, feeders, and branch circuits.

2. Stranded copper conductors for control circuits.

3. Conductor not smaller than 12 AWG for power circuits.

4. Conductor not smaller than 18 AWG for control circuits.

5. Conductor not smaller than 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

6. Conductors not smaller than 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

7. Instrumentation and control signal and communication cabling as specified in 2.3 and 2.4 of this section.

1.5 SUBMITTALS

A. Sections 01 33 00 and 26 05 00

B. Product Data: Submit for building wire, instrumentation cables, and communication cables.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.7 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.8 COORDINATION

A. Section 01 10 00

B. Section 01 30 00

C. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

D. Wire and cable routing indicated is approximate unless dimensioned.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.

B. Unless otherwise shown or indicated, all conductors shall be stranded copper, with 90°C insulation.

2.2 BUILDING WIRE

A. Product Description: Single conductor insulated wire.

B. Conductor: Copper, stranded conductor for all feeders and branch circuits.

C. Minimum Size: 12 AWG.

D. Insulation: NFPA 70; Type THHN-2/THWN-2 insulation for feeders and branch circuits smaller than 2 AWG; Type XHHW-2 for all feeders and branch circuits 2 AWG and larger. Type XHHW-2 may also be used for all feeders and branch circuits smaller than 2 AWG (Contractor's option).

2.3 CONTROL WIRE

A. Product Description: single or multi-conductor insulated wire.
B. Conductor: Copper, stranded conductor.
C. Minimum Size: 18 AWG.
D. Insulation: NFPA 70; Type THHN-2/THWN-2, type TFFN, or type XHHW-2.

2.4 INSTRUMENTATION CABLE

A. 600 volt, NEC Type CL2, general purpose communications cable:

1. Individual Conductors: 16 AWG, stranded, tinned copper, PVC insulation, unless otherwise indicated.

2. Assembly: Twisted pair conductors wrapped with aluminum polyester shield. Drain wire shall be 18 AWG stranded, tinned copper. Shield coverage shall be 100%. Covered with PVC jacket.

2.5 COMMUNICATIONS CABLE

A. Network Cable: Shielded category 6.

2.6 PANEL WIRE

A. Product Description: Single conductor insulated wire.
B. Conductor: Copper, stranded
C. Minimum Size: 16 AWG
D. Insulation: NFPA 70; Type SIS

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify interior of building has been protected from weather.
B. Verify mechanical work likely to damage wire and cable has been completed.
C. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Route wire and cable to meet Project conditions.

B. Install wire and cable in accordance with NECA "Standard of Installation."

C. Neatly train and lace wiring inside boxes, equipment, and panelboards.

D. Ground the shield drain wire at only the supply end.

E. Identify wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

F. Special Techniques--Building Wire in Raceway:

1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.

G. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors.

2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise:

   a. All splices in underground boxes or direct buried shall be insulated and waterproofed, using scotchcast epoxy splicing compounds suited for the purpose.

3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.

4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.

5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 COLOR CODE

A. All service, feeder, and branch circuits conductors shall be color coded, as follows:

1. 120/240V or 120/208V, single or three phases:

a. Phase A: Black

b. Phase B: Red. For 120/240V, 3-phase “high leg” systems, add orange colored tape at both ends and at all accessible locations (terminals, j-boxes, vaults, hand holes, etc.).

c. Phase C: Blue

d. Neutral: White.

2. 480/277V, single or three phases:

a. Phase A: Brown
b. Phase B: Orange
c. Phase C: Yellow
d. Neutral: Light/Natural Gray or White.

B. Equipment Grounding Conductors: Equipment grounding conductors shall be green.

C. Conductor sizes 6 AWG and smaller shall have solid color compound or solid color coating.

D. Conductor sizes 4 AWG and larger shall follow the same color code above, using either:

1. Solid color compound or solid color coating.

2. Stripes, bands, or hashmarks of colors specified above

3. Colored pressure-sensitive plastic or rubber tape. Tape shall be applied in half overlapping turns for a minimum of 3 inches at all terminal points, and at all accessible locations such as junction boxes, pull boxes, troughs, manholes, handholes, etc. Tape shall be at least 3/4-inch wide with colors as specified above. The last two laps of tape shall be applied with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.

E. Multiple Neutral Conductors: When two or more neutrals are located in one raceway, wireway, or tray, individually identify each with proper circuit number and panel of origin.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.
B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. This section covers the work necessary to furnish and install and complete the electrical grounding system.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers:

1. IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems.

2. IEEE 1100) - Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

B. NECA (National Electrical Contractors Association) - Standard of Installation.

C. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.4 SUBMITTALS

A. Sections 01 33 00 and 26 05 00
B. Product Data: Submit data on grounding electrodes and connections.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL (or other NRTL) labeled.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 SYSTEM DESCRIPTION

A. Provide grounding and bonding of electrical service, circuits, equipment, signal, and control systems.

B. Performance Requirements: Supplement the grounded neutral of the secondary distribution system with an equipment grounding system to properly safeguard the equipment and personnel. Install equipment grounding such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment, and other conductive items in close proximity with electrical circuits operate continuously at ground potential and provide a low impedance path for possible ground fault currents.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJ's.

B. Furnish products listed by UL or other NRTL acceptable to AHJ.

PART 2 PRODUCTS

2.1 MATERIALS

A. Grounding Connectors: Hydraulic compression tool applied connectors, exothermic welding process connectors, or powder actuated compression tool applied connectors.

Mechanical type of connectors is not acceptable. Manufacturers: Burndy Hyground Compression System, Erico/Cadweld, Amp Ampact Grounding System, or approved.

B. Pipe Grounding Clamp: Mechanical ground connector with cable parallel or perpendicular to pipe. Burndy GAR Series, O Z Gedney, Thomas & Betts, or approved.

2.2 WIRE

A. Material: Stranded copper.
B. Grounding Electrode Conductor: Copper conductor bare.
C. Bonding Conductor: Copper conductor bare.
D. Equipment Grounding Conductor: Copper with green insulation.

PART 3 EXECUTION

3.1 GENERAL

A. Provide all grounding systems and make connections mechanically secure and electrically continuous. Ground all line voltage electrical systems completely and effectively as required by code and as specified herein.

B. Ground all raceway systems and equipment enclosures. Where not otherwise indicated, grounding conductor size shall conform to the most stringent of the governing codes, except that no grounding conductor shall be smaller than 12 AWG:

1. Ground the service and transformers in an approved manner.

2. Provide grounding were indicated on the drawings. All ground mat conductors shall be bare soft drawn copper, sized as noted. Bury all conductors approximately 12-inches below grade.

3. Grounding conductor connections shall be bolted except at inaccessible ground rods, buried ground conductors, and reinforcing steel grounding conductor connections, where connections shall be brazed, or an irreversible compression system used. Exothermic welded connections may be substituted for brazed connections subject to the Engineer's approval and demonstration on the project with actual test connections that the connections will be successfully made.

4. Equipment grounding conductors, unless otherwise noted, shall be the same insulation type as the circuit conductors and shall be run in conduit.

5. Continuity of equipment ground shall be maintained throughout the entire raceway, cabinet, and equipment enclosure system. Ground bushings and jumpers shall be used wherever normal conduit termination does not ensure continuity.

Where nonmetallic conduit is used for distribution or where direct burial cables are employed, install a green insulated equipment ground conductor with each circuit.

6. Metal parts of lighting fixtures shall be bonded to conduit system with green ground wire. Receptacles shall be grounded to outlet boxes with green ground wire and machine screw.

7. Motors and equipment shall be bonded to the equipment grounding system by a continuous green insulated equipment ground conductor run with each circuit through approved flexible conduit connections as permitted by code. Where flexible conduit size exceeds the code approved limits, provide a separate green grounding conductor inside each flexible conduit, bonded to the inside of the connection box and to the nearest accessible supply end conduit junction box.

3.2 PREPARATION

A. Remove paint, rust, and surface contaminants at connection points.

3.3 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

B. Extend existing grounding system using materials and methods compatible with existing electrical installations, or as specified.

3.4 INSTALLATION

A. Install in accordance with IEEE 142.

B. Install grounding and bonding conductors concealed from view.

C. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

D. Permanently ground entire power system in accordance with NEC, including distribution panelboards, switch and starter enclosures, receptacles, and other exposed non-current carrying metal parts of electrical equipment.

E. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards, switchboards, and motor control centers to grounding bus.

F. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground resistance testing in accordance with IEEE 142.

D. Perform continuity testing in accordance with IEEE 142.

E. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 26 05 29 - ELECTRICAL HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Firestopping relating to electrical work.
7. Firestopping accessories.
8. Equipment bases and supports.

1.3 REFERENCES

A. American Society of Testing Materials:

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.

B. FM (Factory Mutual Engineering Corporation) - Fire Hazard Classifications.

C. NFPA 70 (National Fire Protection Association) - National Electrical Code.

D. NECA (National Electrical Contractors Association) - Standard of Installation.

E. Underwriters Laboratories, Inc. - Fire Resistance Directory:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Test for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.

F. WH (Warnock Hersey) - Directory of Listed Products.

1.4 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.5 SYSTEM DESCRIPTION

A. Firestopping Materials: UL 1479 to achieve fire ratings for adjacent construction.

B. Surface Burning: UL 723 with maximum flame spread / smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.6 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.7 SUBMITTALS

A. Sections 01 33 00 and 26 05 00

B. Anchoring and leveling criteria and recommendations from equipment manufacturers shall be included in the installation recommendation submittal required:

1. Furnish complete dimensioned and scalable shop drawings of all supporting structures, trapezes, and wall supports.

2. Furnish complete anchoring details for pole lights, transformers, control panels, supporting structures, trapezes, wall supports for equipment in excess of 200-pounds, and all freestanding supports:

a. Stamped by a Professional Engineer registered in the State of Oregon.

b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, shall be reviewed for general consistency with the requirements shown in the Contract Documents, but not for context, accuracy, or method of calculation.

3. Include data on attachment hardware and construction methods that satisfy the design loading criteria.

C. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

D. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

2. Firestopping: Submit data on product characteristics, performance, and limitation criteria.

E. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

F. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

G. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

H. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

I. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional ENGINEER suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

C. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.

2.2 CONDUIT SUPPORTS

A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

D. Conduit clamps - general purpose: One-hole malleable iron for surface mounted conduits.

E. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self-locking.

2.3 FORMED STEEL CHANNEL

A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.4 SPRING STEEL CLIPS

A. Product Description: Mounting hole and screw closure.

2.5 SLEEVES

A. Sleeves for Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

B. Sleeves for Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

C. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.6 MECHANICAL SLEEVE SEALS

A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FIRESTOPPING

A. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.

2. Foam Firestopping Compounds: Multiple component foam compound.

3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.

4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.

5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.

6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.

7. Firestop Pillows: Formed mineral fiber pillows.

8. Concrete Grout

B. Color: As selected from manufacturer’s full range of colors.

2.8 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

C. General:

1. Furnish products tested by approved independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

D. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.

2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.
B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing materials to arrest liquid material leakage.

D. Obtain permission from Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Equipment Anchoring:

1. Install equipment in accordance with the printed recommendations of the equipment Manufacturer’s literature, including anchoring methods and leveling criteria.

2. Design, detail, brace, and anchor freestanding equipment supports in place by methods that provide structural support conforming to seismic load, and wind load as indicated in the drawings:

a. Provide pedestals fabricated out of welded angle or tube sections.

b. Lateral deflection at top of supports not to exceed support height divided by 210, unless approved by the ENGINEER.

3. Wall mounted panels that weigh more than 500 pounds or are installed above 18 inches off the floor shall be provided with fabricated steel support pedestals:

   a. If the supported equipment is a panel or cabinet and enclosed with removable side plates, it shall match supported equipment in physical appearance and dimensions.

4. Furnish all conduit racks and trapeze structures needed to support the conduits. Group conduits and position on racks to minimize crossovers, etc.

B. Concrete housekeeping pads are required for all floor-standing electrical equipment and conduit penetrations through floor:

1. Pads shall be a minimum of 3.5 inches above the surrounding floor or grade unless otherwise noted.

2. Pads shall extend a minimum of 2 inches beyond the extent of the equipment in all directions.

3. Pads shall be sized for the actual equipment furnished and all future equipment identified on the Contract Drawings.

4. All edges of the housekeeping pad shall be chamfered.

C. Anchors and Fasteners:

1. Concrete Structural Elements: Provide precast inserts, expansion anchors and preset inserts.

2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.

3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.

4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.

5. Solid Masonry Walls: Provide expansion anchors and preset inserts.

6. Sheet Metal: Provide sheet metal screws.

7. Wood Elements: Provide wood screws.

D. Inserts:

1. Install inserts for placement in concrete forms.

2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

E. Locate and install anchors, fasteners, and supports in accordance with NECA Standard of Installation.

F. Install conduit and raceway support and spacing in accordance with NEC.

G. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

H. Install multiple conduits runs on common hangers.

I. Supports:

1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.

2. Install surface mounted cabinets and panelboards with minimum of four anchors.

3. In wet and damp locations, install steel channel supports to stand cabinets and panelboards 1 inch off wall.

3.4 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit, and other items, requiring firestopping.

B. Apply primer were recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

D. Remove dam material after firestopping material has cured.

E. Fire Rated Surface:

1. Seal opening at wall, and roof as follows:

a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.

b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.

c. Pack void with backing material.

d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

2. Where cable tray, and conduit, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

F. Non-Rated Surfaces:

1. Seal opening through non-fire rated wall, and roof opening as follows:

a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.

b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.

c. Install type of firestopping material recommended by manufacturer.

2. Install escutcheons or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.

3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

4. Interior partitions: Seal pipe penetrations at telecommunication rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 3 inches beyond supported equipment. Refer to Section 03 11 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install stainless steel escutcheons at finished surfaces.

3.7 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. This section covers the work necessary to furnish and install complete electrical raceway systems, including, but not necessarily limited to, conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

1.3 REFERENCES

A. American National Standards Institute:

1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. NECA (National Electrical Contractors Association) - "Standard of Installation"

C. National Electrical Manufacturers Association:

1. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

2. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

3. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

4. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

5. NEMA TC 2- Electrical Polyvinyl Chloride (PVC) Conduit.

6. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

7. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch if exposed or 1 inch if buried or below slab, unless otherwise specified.

B. Coordinate conduit installation to avoid creating trip hazards and blocking equipment access for personnel and maintenance.

1.5 SUBMITTALS

A. Sections 01 33 00 and 26 05 00

B. Product Data: Submit for the following:

1. All conduit types proposed for project.
2. Raceway fittings.
3. Conduit bodies.
4. Wireway.
5. Pull and junction boxes.
6. Handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:

1. Record actual routing of conduits larger than 1.5 inch trade size.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 COORDINATION

A. Section 01 10 00
B. Section 01 30 00

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.

2.2 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1. Galvanized.
B. PVC coated Rigid steel: Federal Specification WW-C-581
C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.3 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

A. Product Description: Interlocked zinc-coated steel core construction with PVC jacket.
B. Fittings: NEMA FB 1.

2.4 NONMETALLIC CONDUIT

A. Product Description: NEMA TC 2, specification WC1O94A and UL 651; Schedule 40 or 80 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.5 REINFORCED THERMOSETTING RESIN (FIBERGLASS) CONDUIT

A. Fiberglass conduit may be used in lieu of PVC conduit.

B. Conduit shall be UL listed for both below ground and above ground installation. Internal conduit and elbow walls shall be smooth, and all fibers embedded in the epoxy. Carbon black shall be used as an ultraviolet inhibitor to protect conduit and fittings. Conduit shall be marked in accordance with NEMA TC 14.

C. Fiberglass conduit fittings, elbows, and accessories shall be manufactured by the same manufacturer as the conduit.

2.6 PVC COATED RIGID STEEL CONDUIT

A. Conduit used in the coating process shall be hot dip galvanized inside and out in accordance with Federal Specification WW-C-581-E, ANSI Standard C-80.1, and UL Standard 6. Finished conduit shall fully conform to the current NEMA RN-1 Standard and shall have a label affixed indicating compliance with UL Standard 6.

B. The zinc surfaces of conduit and fittings shall remain intact and undisturbed on both the interior and exterior throughout the cleaning and coating processes as defined in section 4.3.1 of NEMA RN-1-1989.

C. The PVC exterior coating on conduit, fittings, couplings, accessories, and hardware shall have a minimum thickness of 40 mils, except where part configuration or application dictate otherwise.

D. A polyurethane coating having a nominal thickness of 2 mils shall be applied to the interior of conduit, couplings, elbows, nipples, and feed-through fittings, except were prohibited by design.

E. All conduit threads shall be protected from corrosion by application of a polyurethane coating applied over the manufacturer's standard zinc coating.

F. Use PVC Coated Rigid Steel (PVC-RGS) Conduit in corrosive or hazardous (Classified) areas, unless otherwise noted.

2.7 WIREWAY

A. Product Description: Product Description: Minimum oil-tight and dust-tight type wireway (NEMA 12), or as indicated.

B. Knockouts: None

C. Fittings: Lay-in.

D. Finish: Rust inhibiting primer coating with gray enamel finish.

E. Barriers: Furnish barriers of the same type material as the wireway to form separate compartments for wiring of different systems and/or voltages.

2.8 OUTLET BOXES

A. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

2.9 PULL AND JUNCTION BOXES

A. Hinged Enclosures: As specified in Section 26 27 16.

B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:

1. Material: Galvanized cast iron.

2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 GENERAL

A. No raceway shall be installed until work which might cause damage to wires, conduit boxes, or fittings has been completed; conduit, boxes, fittings, and wires which become damaged in any way shall be removed from the job and replaced at expense of the Contractor.

B. Conduit buried in earth: Provide PVC schedule 40, fiberglass or PVC-RGS. Install raceways to provide not less than 30 inches cover to finished grade. Pitch to drain away from buildings; avoid trapped runs. Grade trenches and place pipe bedding material to provide uniform trench bottom for raceway support. Buried raceway shall not be smaller than 1 inch. Make transition from non-metallic conduit to PVC-RGS for risers under slab.

C. Provide PVC coated rigid steel conduit for all exposed raceway inside building, raceways embedded in structural reinforced concrete, in hazardous areas, for exposed installations where subject to damage, and at all locations not otherwise specified. Conduit installed below the pump disconnect panel shall be continuous run of RGS-PVC with no fittings until conduit system is 12 inches below finished grade.

D. Provide liquid-tight flexible metal conduit connections at all motors and transformers plus other equipment connections subject to vibration. Utilize suitable fittings, keep route neat, at nominal right angles, and in conformance with equipment lines.

E. Exposed conduit shall be run in straight lines parallel to column lines, walls, or beams. Where conduit is grouped, the bends and fittings shall be installed to present an orderly appearance. Unnecessary bending or crossing shall be avoided.

F. Supports for exposed conduit runs shall be furnished and installed within 3 feet of each box. Supports shall be secured by means of expansion inserts in concrete.

G. Conduit and fittings shall be properly protected during the construction period against mechanical injury from any cause. Conduit which extends out of floors, walls, or slabs shall be boxed or otherwise protected and ends shall be capped with metal pipe plugs.

3.2 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.3 INSTALLATION

A. Install raceway and boxes in accordance with NECA "Standard of Installation".

B. Ground and bond raceway and boxes in accordance with Section 26 05 26.

C. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

D. Identify raceway and boxes in accordance with Section 26 05 53.

E. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports.

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit in and under slab from point-to-point.

K. Maximum Size Conduit in Slab Above Grade: 1-inch, unless otherwise indicated. Do not cross conduits in slab.

L. Maintain clearance between raceway and piping for maintenance purposes.

M. Maintain 12-inch clearance between raceway and surfaces with temperatures exceeding 104°F.

N. Cut conduit square using saw or pipe cutter; de-burr cut ends.

O. Bring conduit to shoulder of fittings; fasten securely.

P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

R. Install conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 2-inch size.

S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

X. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings or specified in section for outlet device.

B. Surface mount boxes on block walls.

C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Support boxes independently of conduit.

G. Install gang box where more than one device is mounted together. Do not use sectional box.

3.6 ADJUSTING

A. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.
B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Nameplates
2. Labels
3. Wire markers
4. Conduit markers
5. Stencils
6. Underground Warning Tape
7. Lockout Devices

1.3 SUBMITTALS

A. Sections 01 33 00 and 26 05 00

1.4 CLOSEOUT SUBMITTALS

A. Section 01 33 00

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept identification products on site in original containers. Inspect for damage.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Install nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.

2.2 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

B. Letter Size:

1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

C. Minimum nameplate thickness: 1/8 inch.

2.3 LABELS

A. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.

2.4 WIRE MARKERS

A. Description: Tubing type wire markers, applied to each end of every wire.

B. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number as specified below.

2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams or shop drawings and as specified below.

2.5 CONDUIT AND RACEWAY MARKERS

A. Description: Stencils.

B. Color:

1. Medium Voltage: White lettering on a red background.
2. 480 Volt System: Orange lettering on white background.
3. 240 Volt/208 Volt Systems: Brown lettering on white background.

C. Legend:

1. Medium Voltage System: HIGH VOLTAGE

2. 480 Volt System: 480 VOLTS.
3. 240 Volt/208 Volt Systems: 240 Volts or 208 VOLTS, as applicable.
4. Instrumentation and Control System: INSTRUMENTATION AND CONTROL

D. Tagging:

1. Tag at both ends.

2. Follow Identify circuit type (power, control, lighting), origination equipment and circuit number.

2.6 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

1. Up to 2 inches Outside Diameter of Raceway: 1/2 inch high letters.
2. 2.5 to 6 inches Outside Diameter of Raceway: 1 inch high letters.

2.7 UNDERGROUND WARNING TAPE

A. Description: 4 inch wide plastic tape, colored yellow with suitable warning legend describing buried electrical lines.

2.8 LOCKOUT DEVICES

A. Lockout Hasps:

1. Anodized aluminum or Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:

1. Install nameplate parallel to equipment lines.

2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.

3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.

4. Secure nameplate to equipment front using screws, rivets, or adhesive.

5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.

6. Install nameplates for the following:

    a. Switchboards.
    b. Panelboards.
    c. Motor Control Centers (MCCs)
    d. Transformers.
    e. Motor Controllers, including Drives.
    f. Disconnect Switches
    g. Instruments

C. Label Installation:

1. Install label parallel to equipment lines.

2. Install label for identification of individual control device stations, and input or output devices for the PLC.

3. Install labels for permanent adhesion and seal with clear lacquer.

D. Wire Marker Installation:

1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.

3. Install labels at data outlets identifying patch panel and port designation.

4. Permanently post phase and system identification means at each branch circuit panelboard by using labels.

E. Raceway Marker Installation:

1. Install raceway marker for each raceway longer than 6 feet.

2. Raceway Marker Spacing: 20 feet on center.

3. Raceway Painting: Identify conduit using field painting.

    a. Paint colored band on each conduit longer than 6 feet.

    b. Paint bands 20 feet on center.

    c. Color:

        1) Medium Voltage: Black
        2) 480 Volt System: Orange
        3) 240 Volt / 208 Volt Systems: Brown

F. Underground Warning Tape Installation:

1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 24 19 - MOTOR CONTROL EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. Work consists of all motors and controls specified herein and in other divisions of the specifications. In general, all motors shall be furnished with the driven equipment. Motors and controls are specified in this and other divisions of the specifications. In the event of conflicts, the more restrictive specifications shall apply.

1.2 REFERENCES

A. The following is a list of standards which shall be followed for this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).

2. National Electrical Manufacturers Association (NEMA):

   a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).

   b. ICS 1, Industrial Control and Systems: General Requirements.

   c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.

   d. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

4. Underwriters Laboratories, Inc. (UL):

   a. 98, Enclosed and Dead-Front Switches.

   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.

1.3 SUBMITTALS

A. Sections 01 33 00 and 26 05 00

1.4 QUALITY ASSURANCE

A. Provide products manufactured within scope of Underwriters Laboratories that conform to UL Standards and have applied UL Listing Mark.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping Splits: Established by Subcontractor to facilitate ingress of equipment to final installation location within building.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Pilot devices:

1. Operate at 120VAC unless otherwise indicated.

2. Pushbuttons, Selector Switches, and Pilot Lights:

a. 30.5 millimeter size.

b. Heavy-duty, oil-tight.

c. Panel Lights: 125-Volt full-voltage push-to-test type with LED lamp. Lens colors, as shown.

3. Elapsed (Running) Time Meter (Hrs): Provide a semi-recessed running time meter for all motors. Utilize a non-resettable unit with four registers to indicate up to 9,999 hours. Units that require batteries for any reason are not acceptable.

B. Control/Time Delay Relays and Contacts:

1. Provide control relays as specified and as required to accomplish the control functions indicated. Relays shall be industrial control, general purpose, 3PDT relays. Contacts shall have current and voltage rating as specified by NEMA A600.

C. Starters: Provide combination type starters with instantaneous magnetic circuit breaker and provisions for separate control voltage as shown.

D. NEMA size, design, and rated: NEMA Size 1 minimum.

E. Coordinate magnetic circuit breaker, and overload trip ratings with nameplate horsepower and current ratings of the installed motor.

F. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

G. Full voltage starters:

1. Across-the-line full voltage magnetic starters.

2. Rated for 600 volts.

3. Provide positive, quick-make, quick-break mechanisms, pad lockable enclosure doors.

4. Furnish starter with solid state electronic overload relays.

5. Double-break silver alloy contacts.

6. Reversing starters provided with both mechanical and electrical interlocks to prevent line shorts and energizing both contactors simultaneously.

H. Overloads:

1. Solid state electronic:

a. Selectable Class 10, 20, 30 protection.
b. Ambient insensitive: Operating temperature: -20 to 70 degrees Celsius.

2. Thermal memory.

3. Protective functions:

a. Motor overcurrent.
b. Phase unbalance (adjustable).
c. Phase loss.
d. Ground fault: Provide zero sequence current transformer where required.
e. 120 VAC powered.
f. Visible trip indicator.
g. Push-to-trip test.
h. Isolated normally open alarm contact.
i. Normally closed trip contacts.

2.2 VARIABLE FREQUENCY DRIVES

A. See Section 26 29 23 Variable Frequency Drives.

2.3 SURGE PROTECTION DEVICE (SPD)

A. General: Provide a Surge protective Device (SPD) to be wired directly to the Distribution Swichhboard.

B. SPD shall be rated for 200KA per phase, 480V WYE and be provided with a surge counter.

C. The Surge Protection Device (SPD) shall be Listed and Component Recognized in accordance with UL 1449 Second Edition to include Section 37.3 highest fault current category. SPD shall be UL 1283 listed.

D. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G and shall be suitable for service on high resistance-grounded power distribution systems when the power system is maintained in an overdamped state.

E. SPD shall be modular in design. Each mode including N-G shall be fused with a 200 kAIR UL recognized surge rated fuse and incorporate a thermal cutout device.

F. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided. SPD shall be provided with one set of NO/NC dry contacts.

G. SPD shall meet or exceed the following criteria: Minimum surge current capability (single pulse rated) per phase shall be 200kA per phase.

H. UL 1449 Suppression Voltage Ratings at 480Y/277Volt shall be 600V L-G, L-N, and N-G.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.

2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

3. Install equipment plumb and in longitudinal alignment with pad or wall.

4. Coordinate terminal connections with installation of secondary feeders.

5. Grout mounting channels into floor or mounting pads.

6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

7. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:

    a. Motor served by tag number and equipment name.

    b. Nameplate horsepower.

    c. Motor code letter.

    d. Full load amperes.

    e. Service factor.

    f. Installed overload relay heater catalog number.

    g. Circuit Breakers:

        1) Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

        2) Adjust to approximately 11 times motor rated current.

        3) Determine motor rated current from motor nameplate following installation.

    h. Overload Relay: Select and install overload relay heaters and switch settings after actual nameplate full-load current rating of motor has been determined.

3.2 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner:

1. Installation assistance, and inspection of installation.
2. Functional and performance testing.
3. Plant startup.

END OF SECTION

SECTION 26 27 00 - SERVICE AND DISTRIBUTION

PART 1 GENERAL

1.1 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. Work consists of providing the complete service and distribution system shown on the drawings and specified herein. The requirements of all other sections of the specification are equally applicable to the work to be performed under this section.

1.2 GENERAL

A. See CONDITIONS OF THE CONTRACT and Division 1, GENERAL REQUIREMENTS, and Section 26 05 00, ELECTRICAL - GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are necessary for this project.

1.3 SUBMITTALS AFTER AWARD OF CONTRACT

A. Submittals after award of Contract shall be made in accordance with Division 1, GENERAL REQUIREMENTS, and Section 26 05 00, ELECTRICAL - GENERAL REQUIREMENTS.

B. Provide complete coordination study of the electrical system. Include trip settings and trip curves for each overcurrent device provided in the project, including, but not necessarily limited to, the circuit breaker mounted in the generator, main circuit breaker/service disconnect, motor control center (MCC), motor starters, and panelboards. The coordination study shall conform to the requirements of the latest IEEE standard 242 – Protection and Coordination.

C. The Contractor shall submit a coordination study report to the Engineer for review prior to project completion. The Engineer may direct the Contractor to make adjustments to trip settings based on the coordination study report findings. These adjustments shall be at no additional cost to the Owner.

1.4 ELECTRICAL SERVICE

A. The utility company rendering electrical service to this project is Portland General Electric (PGE). Furnish all labor and install all material not furnished by the utility company, including meter bases, CT cans, and transformer pads or poles as shown, or as required by utility company to render service to the project from utility service point. Verify service point metering requirements, pad construction details, service charges, etc., and include all costs in bid proposal.

B. Provide ground services as required to satisfy utility company and code requirements.

C. Provide trenching and backfill at locations shown on the plans and as required by the utility company for service cable to the project site.

D. For utility service conduit, provide sweeps per utility company standards.

E. Verify all pull boxes, transformer details, and cable details with the utility company and observe utility company standards throughout.

F. The Contractor shall pay all Power Company fees.

1.5 SYSTEM VOLTAGE CHARACTERISTICS

A. Provide electrical system nominal utilization voltage characteristics as follows:

Typical Voltage Description Herein	Nominal Utilization Voltage
480/277	460/265
120/208	115/200
120/240	115/230

PART 2 PRODUCTS

2.1 SAFETY SWITCHES AND DISCONNECTING MEANS

A. Furnish safety switches and disconnecting means where required by the NEC, state and local codes or where required by the AHJ. All equipment shall conform to NEMA standards latest revision as applicable.

B. Switches shall be heavy-duty class, quick-make, quick-break, safety-type, externally operable, with by-passable interlock to prevent opening of cover in "ON" position. Switch shall have positive indication of "OFF" and "ON" position. Devices shall have visible blades unless molded-case breaker mechanism is used. Switches shall be so constructed as to preclude single phasing of switch blades due to mechanical failure. Switches shall be padlockable in the open ("OFF") position. Where indicated, switches shall also be lockable in the closed (“ON”) position.

C. Switches shall be of the proper horsepower, ampere and voltage rating with number of poles required to open all ungrounded conductors and with a solid neutral (S/N) bar where required. Provide auxiliary switch contacts in all disconnect switches to monitor the status of the disconnect switch.

D. Unless otherwise indicated, individually-mounted switches shall be in NEMA type 12 enclosures, except in wet locations, outdoors, or were indicated as weatherproof, in which case NEMA type 4 stainless steel enclosures shall be provided.

2.2 FUSES, 600-VOLT AND LESS

A. Provide fuses as manufactured by Bussmann Manufacturing Company, Chase-Shawmut Company, or equal.

B. Fuses protecting control circuits shall be Bussman "Fusetron", Chase-Shawmut "Trionic," or equal, dual-element type having an interrupting rating of at least 100,000 Amps RMS unless otherwise noted.

C. The following general requirements shall apply to all fuses:

1. Fuses shall be coordinated with each other and with circuit breakers in the circuit.
2. Make adjustments in the specified fuse sizes and provide substitute fuses as required to achieve reliable trouble-free operation of all fused circuits.
3. Provide a fuse in each fuse holder.
4. Provide a label inside each cover or adjacent to each fuse holder indicating specific type of fuse required for replacement.
5. Provide six spare fuses for each low-voltage current rating used on the project, except no spare fuses will be required for integral current-limiting fuse circuit breaker units.

2.3 PANELBOARDS

A. General: Provide panelboards in conformance with the following specification for installation as shown on the drawings.

B. Panelboards shall be dead-front, surface mounted with sub-breakers, main lugs, double lugs, or main breakers as shown on the drawings. Lugs shall be sized for feeders and shall conform to the specification for splicing and terminations. Buses shall be copper, full panel length. Buses shall be identified. Minimum bus rating shall not be smaller than the setting of the feeder protective device. Provide copper ground bus in all panelboards:

1. Unless otherwise indicated, the interrupting rating for panelboards shall be:

a. 480V-Class: 42 kAIC at 480 VAC, minimum; provide higher ratings, if required.
b. 240V-Class: 10 kAIC at 240 VAC, minimum; provide higher ratings, if required.

2. Circuit breakers: Provide molded case bolt-on circuit breakers with thermal magnetic trip units, and a common trip bar for two or three-pole breakers, connected internally to each pole so that the tripping on one pole will automatically trip all poles of each breaker. Handle bales or clips will not be acceptable. Provide breakers of the trip-free and trip-indicating type, with quick-make, quick-break contacts. Provide single, two or three pole breaker interchangeability.
3. Special features: Provide split-bus, sub-feed lugs, sub-feed protective device and contactors as indicated on the drawings or specified in this or other sections of these specifications.
4. Tandem, duplex, or half-sized circuit breakers: Do not use this type of equipment.
5. Lighting and appliance panelboards (240 V class): Minimum breaker interrupting rating shall be 10,000 amps, symmetrical. Provide breakers and panel of higher interrupting rating where indicated on the drawings. Provide minimum box dimensions per NEC.
6. Covers: Covers shall be hinged front. Inside cover shall have panel schedule neatly typewritten in a plastic pouch.

2.4 DRY TYPE TRANSFORMERS

A. General: Provide all power transformer equipment as shown on the drawings in conformance with the following specification. All transformers shall be built in accordance with the latest revised IEEE, ANSI, and NEMA standards. All transformers shall conform to or exceed DOE 2016 energy efficiency standards.

B. Temperature rating: On all transformers, case temperature shall not exceed 30 degrees Centigrade rise above an ambient temperature of 40 degrees Centigrade. Terminal compartment shall be located to ensure termination of cable leads in temperature levels not to exceed 60 degrees Centigrade. Transformers shall be designed for full load operation at a maximum temperature rise of 115 degrees C.

C. Enclosure: For general application, enclosures shall be drip-proof and rodent-proof. Ventilating openings shall be louvered; screening will not be acceptable. Design shall incorporate a built-in vibration dampening system. Finish shall be ANSI 60. Conform to the limited access requirements where applicable.

D. Taps: Furnish four taps, two above and two below rated voltage, each 2 1/2 percent, for ratings above five (5) kVA.

E. Tests: Provide routine tests as listed and described in ANSI specification No. C57.12.00, latest edition.

1. Sound level tests shall be performed on the complete transformer assembly in accordance with the latest NEMA standards. Transformer 0-50 kVA shall conform to NEMA standards.

PART 3 EXECUTION

3.1 EQUIPMENT BASES

A. Provide equipment bases for all floor-mounted electrical equipment. Unless otherwise indicated, bases shall be poured-in-place concrete, nominally 3.5-inches high, and be one inch larger on all exposed edges than the equipment to be mounted. Provide additional surface-mounted channels where required to match and lineup with existing equipment. Provide concrete pads and mounting provisions for all exterior equipment as indicated or specified in other portions of the specifications.

3.2 SUPPORTS

A. Provide hangers or other devices such as pads, channels, struts, joists, anchors, etc., necessary for the support of electrical equipment. Provide the design, fabrication and erection of supplementary structural framing electrical equipment. Show on shop drawing supplementary framing including design loads, member size and location. When supplementary framing is indicated, verify that dimensions are suitable for the equipment furnished. Provide additional strength when equipment furnished is heavier than that specified.

3.3 DAMP AND WET LOCATION

A. Provide 1/4-inch air space behind all electrical equipment mounted in damp and wet locations and on concrete walls below grade. Use corrosion-resistant washers, bolts, and anchors.

3.4 MECHANICAL EQUIPMENT

A. Provide convenience receptacle and disconnect for each mechanical device as required by the NEC.

3.5 START-UP AND TESTING

A. The Contractor shall provide third party testing and certification of any ground fault circuit breakers per the NEC and/or State Codes.

B. The Contractor shall provide switchboard factory authorized personnel for 1 day to perform the following:

1. Inspecting for proper wiring and functionality.
2. Set all circuit breakers, including the generator circuit breaker, per the coordination study specified herein.

C. Provide Engineer with documentation on each setting of each circuit breaker as programmed. Omission of proper documentation shall result in start-up and testing Failure, and cause for the system to be re-tested and re-commissioned at the Contractor's expense.

END OF SECTION

SECTION 26 27 16 - CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. Section includes hinged cover enclosures, cabinets, terminal blocks, and accessories.

1.3 REFERENCES

A. NECA (National Electrical Contractors Association) -Standard of Installation.

B. National Electrical Manufacturers Association:

1. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
2. NEMA 250 - Enclosures for Electrical Equipment (1000V Maximum).

1.4 SUBMITTALS

A. Sections 01 33 00 and 26 05 00

B. Product Data: Submit manufacturer's standard data for enclosures, cabinets, and terminal blocks.

1.5 EXTRA MATERIALS

A. Furnish two of each key.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.

2.2 HINGED COVER ENCLOSURES

A. Construction: NEMA 250, Type 1, 3R, or 4 steel, stainless steel or fiberglass enclosure as indicated or specified.

B. Covers: Continuous hinge, held closed by hasp and staple for padlock.

C. Furnish interior metal panel for mounting terminal blocks and electrical components, finish with white enamel.

D. Enclosure Finish: Manufacturer's standard enamel.

2.3 CABINETS

A. Boxes: Galvanized steel.

B. Box Size: As shown or required.

C. Fronts: Steel, surface type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.

D. Furnish metal barriers to form separate compartments for wiring of different systems and voltages.

E. Furnish accessory feet for free-standing equipment.

2.4 TERMINAL BLOCKS

A. Manufacturers:

1. Allen Bradley
2. AMP
3. Ideal Industries
4. Ilsco Corp.
5. Phoenix Contact
6. Weidmuller

B. Terminal Blocks: NEMA ICS 4

C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

E. Furnish ground bus terminal block, with each connector bonded to enclosure.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Maintain access to existing cabinets and enclosures and other installations remaining active and requiring access. Modify installation or provide access panel.

B. Clean and repair existing cabinets and enclosures to remain or to be reinstalled.

3.2 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner in accordance with Section 26 05 29.

C. Install cabinet fronts plumb.

3.3 CLEANING

A. Clean electrical parts to remove conductive and harmful materials.
B. Remove dirt and debris from enclosure.
C. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. Section Includes:

1. Wall switches.
2. Receptacles.
3. Device plates.
4. Surface covers.

1.2 SYSTEM DESCRIPTION

A. Provide devices and finish plates for a complete and operational electrical system.

1.3 SUBMITTALS

A. Provide Product Data for the Following Equipment:

1. Wall switches.
2. Receptacles.
3. Finish plates.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.

B. Furnish products listed by UL or another testing firm acceptable to AHJ.

C. Federal Specification Compliance: Comply with Federal Specification WS896 and WC596 for switches and receptacles, respectively.

D. NEMA Configuration: Comply with NEMA configurations and standards for general `and special purpose wiring devices.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Characteristics: Toggle type, quiet acting, heavy duty industrial grade, 20 amp, 120/277 volt, UL listed for motor loads up to 80 percent of rated amperage. Manufacturers: Arrow-Hart, Leviton, Pass & Seymour, Bryant, Hubbell, or approved.

B. Finish: Gray finish unless selected otherwise by Engineer. Provide Engineer with optional colors for selection prior to ordering.

C. Appearance: Provide lighting switches and receptacles of common manufacturer and appearance.

D. For outdoor locations provide switches and covers rated for wet locations.

2.2 RECEPTACLES

A. Finish: Same exposed finish as switches. Receptacles connected to emergency circuits, red finish.

B. Characteristics: NEMA 5-20R configuration, heavy duty industrial grade, 20 amp, 125 volt, 2-pole, 3-wire grounding. Manufacturers: Arrow-Hart, Leviton, Pass & Seymour, Bryant, Hubbell, or approved.

C. Ground Fault Interrupter: Feed through type, 20 amp, 125VAC, specification grade. Manufacturers: Arrow-Hart, Leviton, Pass & Seymour, Bryant, Hubbell, or approved.

D. Wet Locations: Weatherproof receptacles installed in wet locations, approved for location and use.

1. Single Receptacle Cover: Continuous use approved.

2. Duplex Receptacle Covers: Continuous use approved.

3. Cord Caps: Equip utilization equipment connected to wet location receptacles with barrel type plug similar to Hubbell 5266-C.

4. Provide continuous use cover with cover capable of closing over energized cord cap with bottom aperture for cord exit.

5. For outdoor locations provide lockable cover.

2.3 FINISH PLATES

A. Material: 18 percent chrome, 8 percent nickel, Type 302 stainless steel, smooth satin finish metal. Hubbell S Series, Arrow-Hart, Leviton, Pass & Seymour, Bryant.

2.4 SURFACE COVERS

A. Material: Galvanized or cadmium plated steel, 1/2-inch raised industrial type with openings appropriate for devices installed on surface outlets.

PART 3 EXECUTION

3.1 PREPARATION

A. Protection:

1. Devices: Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of substantial completion, replace those items which have been damaged, including those burned and scored by faulty receptacles or cord caps.

2. Finish Plates and Devices: Do not install items until finish painting is complete. Scratched or splattered finish plates and devices not acceptable.

3.2 INSTALLATION

A. Plumb: Install devices and finish plates plumb with building lines and equipment cabinets.

B. Orientation:

1. Wall Mounted Receptacles: Install with long dimensions oriented vertically at centerline height shown on Drawings or specified herein.

2. Vertical Alignment: When than one outlet is shown on Drawings in close proximity to each other, but at different elevations, align the outlets on a common vertical centerline for best appearance. Verify with Engineer.

3.3 FIELD QUALITY CONTROL

A. Wiring Device Tests: Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.

END OF SECTION

SECTION 26 29 23 - VARIABLE FREQUENCY DRIVE

PART 1 GENERAL

1.1 SUMMARY

A. The Variable Frequency Drive (VFD) systems shall contain all components required to meet the performance, protection, safety, and certification criteria of this specification.

B. The VFDs shall be used:

1. With new pumps/motors in a wastewater pumping application

C. Unless otherwise indicated or allowed, VFDs are to be installed as separate wall mount units, complete with all required accessories and appurtenances.

1.2 REFERENCES

A. National Fire Protection Association - NFPA 70 - US National Electrical Code.

B. National Electrical Manufacturers Association - NEMA 250 - Enclosures for Electrical Equipment.

C. Underwriters Laboratory Inc. – UL 508.

D. Canadian Standards Association International – CAN/CSA-C22.2 No. 14-05.

E. International Electrical Code - IEC 146.

F. Institute of Electrical and Electronics Engineers, Inc. - IEEE 519 - IEEE Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings – Approval:

1. Elevation Drawings: Include dimensional information and conduit routing locations.
2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
3. Wiring Diagrams:

a. Power Diagram: Include amperage ratings, circuit breaker frame sizes or fused disconnect rating, circuit breaker or fuses continuous amp ratings, etc. as required for approval.

b. Control Diagram: Include disconnect devices, pilot devices, etc.

4. Major components list.

C. Product Data Sheets:

1. VFD and Operator Interface publications.
2. Data sheets and publications on all major components including but not limited to the following:

a. Line reactor
b. Circuit breaker and fuse (power and control), if used
c. Control power transformers
d. Pilot devices
e. Relays/Timers

D. Test procedures shall be per the manufacturer's standards.

1.4 CLOSEOUT SUBMITTALS (OPERATION AND MAINTENANCE MANUALS)

A. Submit under provisions of Division 1.

B. Shop Drawings – Final as shipped:

1. Elevation Drawings: Include dimensional information and conduit routing locations.
2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
3. Wiring Diagrams:

a. Power Diagram: Include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.
b. Control Diagram: Include disconnect devices, pilot devices, etc.

4. Major components list.

C. Product Data Sheets:

1. VFD and Operator Interface publications.
2. Data sheets and publications on all major components including but not limited to the following:

a. Line reactors
b. Circuit breaker and fuse (power and control), if used
c. Control power transformers
d. Pilot devices
e. Relays/Timers

D. Test procedures shall be per the manufacturer's standards.

E. Operation and Maintenance Data:

1. Service and Contact information
2. VFD and Operator Interface User Manuals
3. VFD Setup Parameters Sheet
4. Troubleshooting / Service Manuals

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturing:

a. The VFD and all associated optional equipment shall be UL listed or recognized.
b. The VFD shall contain a UL label attached on the inside of the enclosure cabinet.

2. Suppliers:

a. All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system and must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.
b. The VFD shall be factory pre-wired, assembled and tested as a complete package.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall coordinate the shipping of equipment with the manufacturer.

B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of -25 °C to 55 °C (-13 °F to 130 °F).

C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.7 WARRANTY

A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

B. This warranty applies to variable frequency drive systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Allen-Bradley PowerFlex 755

B. ABB ACS 800 Series

C. Eaton CPX Series

D. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.2 VARIABLE FREQUENCY DRIVE UNIT

A. Features:

1. Certifications:

a. Stand-alone Enclosure: Listed to UL508C and CAN/CSA-C22.2 No. 14-05
b. In conformity with EMC Directive (2004/108/EC) and Low Voltage Directive (2006/95/EC). Standards applied; EN 61800-3:2004, EN 61800-5-1:2007.
c. Electric Power Research Institute. Certified compliant with standards SEMI F47 and IEC 61000-4-34

2. Hardware:

a. Utilize eighteen-pulse with three full-wave bridges on the input.
b. Utilize DC bus inductor ("choke").
c. Utilize switching logic power supply operating from the DC bus.
d. Incorporate phase to phase and phase to ground MOV protection on the AC input line.
e. Utilize gold plated plug-in connections on printed circuit boards.
f. Microprocessor based inverter logic shall be isolated from power circuits.
g. Utilize latest generation IGBT inverter section with PWM with programmable carrier frequency.
h. Control transformer 500 VA with 120V secondary for operating the ball valve (customer’s request).
i. Battery receptacle for Lithium battery power to the Real Time Clock.
j. Conformal coated printed circuit boards.
k. Onboard 24V DC Auxiliary Control Power Supply.

3. Control Logic:

a. Ability to operate with motor disconnected.

b. Provide a controlled shut down, when properly protected, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
c. Provide multiple acceleration and deceleration rates.
d. Adjustable output frequency up to 120Hz.
e. Ability to control outputs and manage status information locally within the VFD.
f. Ability to function stand-alone.
g. Ability to provide selector switches, or other data manipulations not already built into the VFD.

4. Motor Control Modes:

   a. Control modes of V/Hz and Adjustable Voltage Control selectable through programming.
   b. The drive shall be supplied with a Start-up and Auto-tune mode.
   c. The V/Hz mode shall be programmable for full custom patterns.
   d. Capable of Open Loop V/Hz.

5. Current Limit:

   a. Programmable current limit from 20 to 160% of rated output current.
   b. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.

6. Acceleration / Deceleration:

   a. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 180 seconds, minimum.
   b. A second set of remotely selectable accel/decel settings shall be accessible through digital inputs. (OPTIONAL)

7. Speed Profiles:

   a. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration that provide changing accel/decel rates.

8. Adjustments:

   a. A digital interface can be used for all set-up, operation, and adjustment settings.
   b. All adjustments shall be stored in nonvolatile memory (EEPROM).
   c. No potentiometer adjustments shall be required.
   d. EEPROM memory for factory default values shall be provided.
   e. Software must be available for trending and diagnostics, as well as online and offline programming functionality.

9. Skip Frequencies:

    a. A minimum of three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.

10. Fault Reset/Run:

    a. The drive shall provide an adjustable number of the automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
    b. The automatic mode shall not be applicable to a ground fault, shorted output faults and other internal microprocessor faults.
    c. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.

11. Fault Memory:

    a. Information about the drive's condition at the time of the last fault such as operating frequency, output current, dc bus voltage and twenty-seven other status conditions shall be stored for additional troubleshooting reference.

12. Overload Protection:

    a. The drive shall provide internal speed sensitive adjustable overload protection.
    b. A viewable parameter shall store the overload usage.

13. Inputs and Outputs:

    a. Provide 24 VDC I/O, unless otherwise noted. Drive shall be capable of providing an internal 24 VDC supply or utilizing an external 24 VDC power supply for use with the I/O.
    b. All digital input and output functions shall be fully programmable.
    c. Digital Inputs: There shall be a minimum of six (6), independently programmable digital inputs. Input functions shall be selectable from a list of at least 25 functions including stop, start (2-wire control), run (3-wire control), auxiliary (or "external") fault, speed select, and jog.
    d. Digital Outputs: There shall be a minimum of three (3) independently programmable relay outputs, at least one of which is Form C. Non-form C relays shall be programmable as either NO or NC. Relay contacts shall be rated 2 Amps (minimum) at 24 VDC or 115/230 VAC. Output functions shall be selectable from a list and shall include ready, fault, at speed/freq, at torque, and running, as a minimum.

e. Analog Inputs: There shall be a minimum of two (2) programmable analog inputs, each independently selectable as 0-10V DC or 4-20mA DC. Analog input functions shall be selectable from a list of input function selections. Analog input signal processing functions shall include scaling adjustments, adjustable filtering, and signal inversion.
f. Loss of Reference: The Drive shall be capable of sensing reference loss conditions. If the input reference (4-20mA or 0-10V) is lost, the Drive shall perform one of the user programmable functions:

    1) Fault the drive and coast to stop,
    2) Alarm (but not fault the Drive) and run at a programmable preset speed, or
    3) Alarm (but not fault the Drive) and hold the Drive speed based on the last good reference received.

g. Analog Outputs: There shall be a minimum of two (2) programmable analog outputs, providing 4-20mA DC signals. Analog output functions shall be selectable from a list of output function selections including output speed, frequency, voltage, current, and power, as a minimum.
h. Ethernet: The Drive shall have an integral Ethernet port.

14. Reference Signals:

    a. The drive shall be capable of using the following input reference signals:

        1) Analog inputs
        2) Preset speeds.
        3) Remote potentiometer
        4) Human Interface Module
        5) Communication modules

15. Metering:

    a. At a minimum, the following parameters shall be accessible through the Human Interface Module, if installed:

        1) Output Current in Amps
        2) Output Voltage in Volts
        3) Output Power in kW
        4) Elapsed MWh
        5) DC Bus Voltage
        6) Frequency
        7) Heatsink Temperature
        8) Last eight faults
        9) Elapsed Run Time
        10) IGBT Temperature

11) Faults

b. At a minimum, the following faults shall be accessible through the Human Interface Module:

1) Power Loss
2) Undervoltage
3) Overvoltage
4) Motor Overload
5) Heat Sink Over-temperature
6) Phase to Phase and Phase to Ground Faults

16. Real-Time Clock:

a. Shall be capable of providing time stamped events and have the ability to be set locally or via a remote controller.

2.3 VFD SYSTEM

A. General: Due to concerns about possible utility voltage imbalance, VFDs are to be sized with an output amperage rating of 1.4x motor FLA, minimum, as if VFDs would drive 3-phase motors while powered from a single-phase source without damaging drive.

B. Ratings:

1. Voltage:

a. Capable of accepting nominal plant power of 480V AC at 60Hz.
b. The supply input voltage tolerance shall be + 10%/-15% of nominal line voltage.

2. DC Input Voltage Tolerance: +/-10% of nominal DC bus voltage.
3. Frequency tolerance: 47 to 63 Hz.
4. Power Factor of 0.95 or better at rated load and nominal line voltage, over the entire speed range.
5. Efficiency:

a. A minimum of 96% (+/- 1%) at 100% speed and 100% motor load at nominal line voltage.
b. Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.

6. Operating ambient temperature range without derating: 0 °C to 40 °C (32 °F to 104 °F)
7. Operating relative humidity range shall be 5% to 95% non-condensing.
8. Operating elevation shall be up to 1000 Meters (3,300 ft) without derating.

9. The drive shall be protected from vibration per IEC 68-2-6 (max. Sinusoidal displacement 1.5 mm, 2 Hz to 9Hz and max. Acceleration 5m/s2, 9Hz to 200Hz).

C. Short Circuit Rating: not less than 42 kA.

D. Sizing and Intermittent Overload:

1. Systems rated at Normal Duty loads shall provide 110% overload capability for up to one minute and 150% for up to 3 seconds.
2. Systems rated at Heavy Duty loads shall provide 150% overload capability for up to one minute and 180% for up to 3 seconds.
3. Pump systems shall be heavy duty rated. Fan systems can be normal duty rated.

E. The incoming overvoltage trip level shall be a minimum of 30% over nominal, and the undervoltage trip level shall be a minimum 35% of under the nominal voltage.

F. Motor phase loss protection shall be provided.

G. Ride-Through:

1. The VFD system shall attempt to ride through power dips up to 20% of nominal. The duration of ride-through shall be inversely proportional to load. For outages greater than 20%, the drive shall stop the motor and issue a power loss alarm signal to a process controller.
2. In case of power outage, the VFD system ride-through shall be not less than 15 milliseconds at full load.
3. Logic control ride through 0.5 sec minimum, 2 sec typical.

H. Line transient:

1. Up to 6000 volts peak per IEEE C62.41-1991.

I. Carrier frequency: shall be adjustable between 2 and 8 kHz. The maximum carrier frequency can differ depending on the type of the drive.

J. Drive output: output voltage and current rating shall match the adjustable frequency operation requirements of standard 460VAC, 3ph, 60Hz, NEMA design B motor.

K. Enclosure Door Mounted Human Interface Module (HIM):

1. VFD shall provide an HIM with integral display, operating keys, and programming keys.
2. An optional VFD-mounted HIM may be provided and shall be capable of connecting via a separate cable for use as a handheld terminal.
3. The HIM shall indicate drive operating conditions, adjustments, and fault indications, and provide digital speed control.

L. Ethernet Interface: Drives shall be provided with Ethernet interface for connection to the control system.

M. Drive Enclosure Input Disconnect:

1. Provide a door interlocked disconnect.
2. Operator Handles:

    a. Provide externally operated main disconnect handle.
    b. Handles shall be lockable with a minimum of one lockout / tag-out padlock position.

N. Control Power Transformers:

1. Provide a control power transformer mounted and wired inside of the drive system enclosure.
2. The transformer shall be sized (VA rating) for the VFD power requirements.

O. Auxiliary (Interpose) Relays:

1. Provide relays for Drive Alarm, Drive Fault, Drive Run, and System Status Faults (as may be required – see motor control diagrams).
2. Provide 3PDT relays with contacts rated for 115V AC/30V DC, 5.0 amp resistive, 2.5 amp inductive.

P. Control Interface:

1. The control terminals shall be rated 115V AC, minimum.
2. The control interface shall provide input terminals for access to VFD functions that include start, stop, external fault, speed select, and enable, as required.

Q. Pilot Devices:

1. Provide a "Hand/Off/Auto" (HOA) selector switch mounted on the enclosure door:

    a. When the HOA is in the "Off" position, the drive shall be stopped and not allowed to start from any source (pushbuttons, control interface, or communications module).
    b. When the HOA is the "Hand" position, drive may be controlled by "Start" and "Stop" pushbuttons and a speed adjusting potentiometer.
    c. When HOA is in "Auto" position, drive may be controlled by remote contacts or communications module.
    d. When an HIM is present, the stop function shall always be available to stop the drive regardless of the selected mode (“Hand” or “Auto”); the HIM shall stop the drive if the switch is in the “Auto” mode with the remote start contact initiated.

e. Provide a speed adjusting potentiometer, for operation in "Hand" mode.

2. Provide "Start" and "Stop" momentary pushbuttons with flush heads, for operation in "Hand" mode.
3. Provide a drive "reset" momentary pushbutton.
4. Provide LED pilot lights, mounted on the enclosure door, for indication of the following status:

   a. Run
   b. Drive/Motor Fault
   c. Control Power On

R. Motor Run Time Meter:

1. Provide a digital, non-resettable, door-mounted elapsed time meter.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that location is ready to receive equipment.

B. Verify that the building environment can be maintained within the service conditions required by the manufacturer of the VFD.

3.2 INSTALLATION

A. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.

3.3 START-UP SERVICE

A. At a minimum, the start-up service shall include:

1. Perform pre-Power Check.
2. Verify power and signal grounds.
3. Check connections.

B. Drive Power-up and Commissioning:

1. Measure Incoming Power Phase-to-Phase and Phase-to-Ground.
2. Measure DC Bus Voltage
3. Measure AC Current Unloaded and Loaded
4. Measure Output Voltage Phase-to-Phase and Phase-to-Ground
5. Verify input reference signal.

C. All measurements shall be recorded.

D. Drive shall be tuned for system operation.

E. Drive parameter listing shall be provided.

3.4 TRAINING

A. Manufacturer to provide on-site instructions.

B. The instructions shall include the operational and maintenance requirements of the variable frequency drive.

C. The basis of the training shall be the variable frequency drive, the engineered drawings, and the user manual. At a minimum, the training shall:

1. Review the engineered drawings identifying the components shown on the drawings.
2. Review starting / stopping and speed control options for the controller.
3. Review operation of the Human Interface Module for programming and monitoring of the variable frequency drive.
4. Review the maintenance requirements of the variable frequency drive.
5. Review safety concerns with operating the variable frequency drive.

END OF SECTION

SECTION 26 32 13 - STANDBY POWER SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. The work consists of furnishing electric generating set with features and accessories as specified herein and shown on the drawings.

B. Standby Power System shall consist of:

1. A diesel engine-driven, standby generator with an alternator rated 480/277-volt, 3-phase, 60 Hz; digital (micro-processor based) electronic generator set control system; and fuel transfer pump, if required. Minimum rating of the generating sets will be as shown.

2. Automatic Transfer Switch (ATS), as described below.

1.2 GENERAL REQUIREMENTS

A. Materials and workmanship:

1. Materials and parts comprising the standby power system specified herein shall be new, unused, of current manufacture and of the highest grade, free from all defects.

2. Workmanship shall be the highest grade, in accordance with modern practice.

B. Parts and service: Bidders shall specify nearest location of permanent parts depots from which replacement parts may be obtained in necessary quantities at any time, day, or night. Service facilities and personnel shall be equally available.

1.3 GENERATOR SET PERFORMANCE

A. Steady-State Voltage Operational Bandwidth: 0.25% of rated output voltage from no load to full load.

B. Steady-State Voltage Modulation Frequency: Less than one Hz.

C. Transient Voltage Performance: Not more than 15 percent variation for 50 percent step-load increase; not more than 10 percent variation for 50 percent step-load decrease. Voltage recovers to remain within the steady-state operating band within 2 seconds.

D. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

E. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.

F. Transient Frequency Performance: Less than 4-Hz variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within 2.5 seconds.

G. Output Waveform: At no load, harmonic content measured line-to-line or line-to-neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, does not exceed 50.

H. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at the system output terminals, the system will supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.

I. Temperature Rise of Generator: Within limits permitted by NEMA MG 1 when operating continuously at full-rated load, including 2 hours per 24 hours at 110 percent of rated capacity.

J. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, is 7 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands.

1.4 SUBMITTALS

A. Product Data: For each component. Include data on features, components, ratings, and performance. Include dimensioned outline plan and elevation drawings of engine generator set and other system components.

B. Shop Drawings: Show details of fabrication, piping, wiring, and installation of field-installed portions of system. Include general arrangement drawings showing locations of auxiliary components in relation to engine generator set and duct, piping, and wiring connections between generator set and auxiliary equipment. Show connections, mounting, and support provisions and access and workspace requirements.

1. Wiring Diagrams: Show details of power and control connections and differentiating between factory-installed and field-installed wiring.

C. Qualification Data: For firms and persons specified in the "Quality Assurance" Article.

D. Field Test and Observation Reports: Indicate and interpret test results for compliance with performance requirements.

E. Certified Test Reports of Components and Accessories: For devices that are equivalent, but not identical, to those tested on prototype unit.

F. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet critical performance criteria.

G. Factory Test Reports: For units to be shipped for this Project showing evidence of compliance with specified requirements.

H. Exhaust Emissions Test Report: To show compliance with applicable, current regulations.

I. Sound measurement test report.

J. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

K. Field test report of tests specified in Part 3.

L. Maintenance data for system and components to include in the maintenance manuals specified in Division 1. Include the following:

1. List of tools and replacement items recommended to be stored at the site for ready access. Include part and drawing numbers, current unit prices, and source of supply.

2. Detail operating instructions for both normal and abnormal conditions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing equipment of types and capacities similar to those indicated for this Project and with a service center maintained by engine generator set manufacturer capable of providing training, parts, and emergency maintenance and repairs at the Project site with 24 hours maximum response time.

B. Source Limitations: Obtain engine generator set and auxiliary components from a single manufacturer with responsibility for entire system.

C. Listing and Labeling: Provide system components of types and ratings for which listing or labeling service is established and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

D. Comply with NFPA 70.

E. Comply with NFPA 99.

F. Comply with NFPA 704, Hazard Identification signage.

G. Engine Exhaust Emissions: Comply with all current, applicable federal, state, and local government requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty signed by Contractor and manufacturer, with single-source responsibility for engine generator and auxiliary components, agreeing to repair or replace items that do not meet requirements or that deteriorate as defined in this Section within the specified warranty period.

C. Warranty Period: 5 years (for engine-generator set) from date of Substantial Completion. Warranty shall cover 100% parts (except consumables unless consumables were damaged by the failure) and labor. Warranty shall also include coverage of temporary rental generator costs up to $20,000 if repairs cannot be completed within 48 hours of inspection by manufacturer’s authorized technician.

1.8 MAINTENANCE SERVICE

A. Maintenance: Beginning at Substantial Completion, provide 12 months full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies as used in the manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. Deliver extra materials to Owner.

1. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.
2. Indicator Lamps: 2 for every 6 of each type used, but not less than 2 of each.
3. Filters: One set each of lubricating oil, fuel, and combustion air filters.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Caterpillar/Peterson Power

2. Cummins/Onan

3. Kohler

4. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.2 SERVICE CONDITIONS

A. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 deg C to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 3,000 feet (909 m).

B. Unusual Service Conditions: Engine generator equipment and installation is required to operate in the following conditions:

1. Applicable seismic requirements as defined in the International Building Code (IBC) for the location of installation.

2.3 DIESEL ENGINE-GENERATOR SET

A. Rating: The generator rating is summarized below:

1. kW (Standby) rating as shown on the drawings, 480/277 V, 60 Hz, three-phase, 4 wire, 0.8 Power Factor.

B. Generator Set Performance: As specified in 1.04.

1. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

2. The generator set shall be capable of starting a minimum of 90% of rated kVA load at no more than 35% voltage dip applied to the generator set.

C. AC Generator, Regulator and Exciter Units:

1. The AC Generator shall comply with NEMA MG 1 and specified performance requirements. The generator shall be synchronous, four pole, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc(s). Exciter shall rotate integrally with generator rotor. All insulation system components shall meet NEMA MG1 standard temperature limits for Class H insulation systems. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees C. The generator shall have 2/3 pitch stator winding. The subtransient reactance 15 percent, maximum.

2. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices. The automatic voltage regulator shall be temperature compensated, solid-state design.

3. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include an under frequency rolloff torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 hertz. The torque-matching characteristic shall include differential rate of frequency change compensation to the maximum available engine torque and provide optimal transient load response. Regulators that use fixed volts per hertz characteristic are not acceptable. The voltage regulator shall have adjustable rheostat on control and monitoring panel to provide plus or minus 5 percent adjustment of output voltage operating band.

4. The generator shall be broad range, 12 lead reconnectable. Instrument transformers shall be mounted within generator enclosure. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage within the broad range.

D. Engine-Generator Set Controls:

1. The controls shall be digital (microprocessor based) electronic, fully NFPA 110 compliant, and shall have automatic remote start capability from a panel-mounted 3-position (Stop, Run, Remote) switch.

2. Provide cycle cranking of 15 SEC (ON)/15 SEC (OFF) for three attempts (75 SEC). If engine fails to start, lockout the engine, and indicate overcrank on alarm status panel.

3. The control shall shut down and lock out upon:

   a. Failing to start (overcrank)
   b. Overspeed
   c. Low lubricating oil pressure
   d. High engine temperature
   e. Operation of a remote manual stop station.

4. The NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. A front control panel illumination lamp with ON/OFF switch shall be provided. Control panel shall provide a multi-line LCD display capable of displaying the following:

   a. Engine Oil Pressure

   b. Coolant Temperature

   c. DC Voltage

   d. Total Run Time (hours)

   e. Output AC Voltage, for each phase, simultaneously

   f. Output AC Amperage, for each phase, simultaneously

   g. Output Frequency

   h. Alarms and Warnings - as a minimum, the following alarms and warning shall be displayed upon activation:

      1) Overcrank shutdown

2) Overspeed shutdown
3) Low oil pressure shutdown
4) High engine temperature shutdown
5) High engine temperature pre-alarm
6) Low engine oil pressure pre-alarm
7) Low coolant temperature
8) Low coolant level
9) Low fuel
10) Not in automatic start

E. Engine: The engines shall be 1800 RPM, diesel.

1. Governing: The unit shall have an engine speed electronic governor to provide isochronous generator set frequency control. The governor shall be capable of parallel operation with the addition of load sharing controls.

2. Cooling Systems: The engines shall be cooled by a skid-mounted closed loop horizontal radiator systems, including centrifugal fan, coolant pump and thermostat temperature control. The cooling system shall be rated for full rated load operation in 122 degrees F (50 degrees C), minimum, ambient conditions. The size of radiator shall be adequate to contain expansion of total system coolant from cold start to 110 percent load condition. The cooling system, including cooling air flow paths, shall be designed to minimize noise. The cooling capability of the generator set shall be demonstrated by prototype tests on a representative generator set model. The provided engine thermostat shall regulate engine water temperature as recommended by the manufacturer. Provide a high-coolant temperature device to shut down the engine through the engine control panel when the engine temperature exceeds 200 degrees F. The engine cooling system shall be filled with an extended life coolant to protect the system to a temperature of 0 degrees F.

3. Engine Fuel System: Comply with NFPA 30. Fuel: Diesel fuel oil grade DF-2.

4. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft.

5. Accessories: To include:

   a. An electric starter capable of three complete cranking cycles

   b. Block (coolant) heater(s), size as recommended by manufacturer. Block heater(s) shall be 208V, 1-phase. For block heaters larger than 1500 Watts, provide an optional 480V-240V, 1-phase step-down transformer, sized to power the block heater, for connection to a 480V, 1-phase circuit.

c. Battery charger with “high charge” option

d. Positive displacement, mechanical, full pressure, lubrication oil pump.

e. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

f. Fuel filter with replaceable spin-on canister element.

g. Replaceable dry element air cleaner with restriction indicator.

h. Flexible supply and return fuel lines.

i. Engine mounted battery charging alternator, 45 ampere minimum, and solid-state voltage regulators.

j. Starting batteries with 1400-ccA, 200-AH operation and 425 minutes of reserve capacity.

6. Engine Exhaust System: Exhaust silencer (muffler) shall be provided for the engine of size as recommended by manufacturer. Silencer shall be chambered construction of the super critical type and shall have aluminized finish for corrosion resistance. Contractor shall mount silencer, so the engine does not support its weight. Provide flexible exhaust connection as shown for connection between engine exhaust manifold(s) and exhaust line. Provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensation from entering the engine. Contractor shall mount and install all exhaust components as shown on drawings and as required for code compliance. All components shall be properly sized to assure proper operation without excessive back pressure when installed as shown on drawings. Make provisions as required for pipe expansion and contraction. Contractor shall cover exhaust silencer (where mounted indoors) and all indoor exhaust piping with a proper insulating material in a manner not to interfere with flexible exhaust connection(s).

F. Bases: The engine-generator set will be mounted with vibration isolators on a heavy-duty steel base to maintain proper alignment between components. The engine-generator set shall incorporate a battery tray with battery hold down clamps within the base rails. The engine-generator sets will have Seismic Zone 3 isolator pads for mounting.

G. Main Circuit Breaker: Provide a generator mounted circuit breaker, molded case, 3 pole, NEMA 1/IP22, which will disconnect the generator from the supply circuit. Circuit breaker to be sized as shown. Breaker shall utilize a solid-state trip unit and shall have the electrical characteristics, rating, and modifications as shown. The breaker shall be UL/CSA Listed and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the

generator set and shall have a metal nameplate that contains a permanent record of the circuit breaker catalog number and maximum ratings. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker.

1. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated drawing. The solid-state trip circuit breaker shall include the following adjustments: each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments:

    a. An ampere trip setting (long time pickup) that is adjustable from 0.5 times (or less) to 1.0 times the plug ampere rating, in 0.1 (or less) increments.

    b. An adjustable long time pickup delay, with a minimum of 5 different delay settings.

    c. A short time pickup trip setting that is adjustable from 2 times (or less) to 9 (or greater) the long time ampere trip setting.

    d. An adjustable short time pickup delay, with a minimum of 5 different delay settings.

    e. An instantaneous pickup that is capable of being disabled (preferable) or is adjustable from 1.5 times (or less) to 15 times (or greater) the long time ampere trip setting. Units that are capable of disabling the instantaneous pickup shall be configured with the instantaneous pickup disabled.

2. Main Circuit Breaker shall have a quick-make, quick break, over-center toggle type, trip-free mechanism to prevent holding contacts closed against a position between "ON" and "OFF" when tripped automatically. Breaker shall be common trip such that an overload or short circuit on any one pole will result in all poles opening simultaneously.

3. The interrupting capacity of the Main Circuit Breaker shall be 14 kAIC at 480 volts, minimum.

2.4 OUTDOOR ENCLOSURE

A. (This section to be completed for 100%)

2.5 AUTOMATIC TRANSFER SWITCHES

A. Furnish and install where indicated a “programmed (delayed) transition” style automatic transfer switch with ratings, features/accessories, enclosures, etc. indicated

on the drawings or noted herein. To maintain maintenance compatibility, automatic transfer switches shall be approved by engine-generator manufacturer:

1. ATS shall be 3-pole with solid neutral, interlocked circuit breakers mounted in the service switchboard as shown:

    a. ATS shall have a separate Circuit Breaker (CB) compartment to keep the service entrance conductors isolated from non-service entrance conductors. CB to be connected to the "utility" or "normal power" contacts of the ATS. Trip rating of CB shall be as shown. See section 26 27 00 for circuit breaker specifications.

    b. Circuit breakers with frame sizes of 225 Amps or larger shall have fully adjustable, solid-state trip units, of the Long, Short, and Instantaneous (LSI) type. Long and short (LS) adjustments shall include independently adjustable delay settings, with a minimum of (5) different delay time settings. Where required or shown, Ground Fault Interruption (GFI) adjustments shall be included.

B. The transfer switch equipment as specified herein shall be 100% equipment rated for continuous duty at the ratings shown on the plans and shall conform to the applicable requirements for UL 1008 for emergency total system load. All transfer switch equipment supplied shall bear the UL label.

C. All main power contacts shall be rated for multiple fault interruptions per UL 489, and/or UL 1087. Main contacts shall have independent "break-before-make" transfer action which shall positively prevent dangerous "source-to-source" connections.

D. Automatic transfer switches specified herein shall consist of completely enclosed contact assemblies and a separately mounted control logic panel. Control power for all automatic transfer operations shall be derived from the line side of the source to which the load is being transferred.

E. Automatic transfer switches specified here shall have full, 3-phase voltage monitoring, including phase imbalance as well as phase loss:

1. Upon loss of phase-to-phase voltage of the normal power source on any phase to 70% of nominal, and after a time delay of 0-5 seconds (minimum; adjustable to meet conditions present) to override momentary dips and/or outages, starting of the emergency/standby power source shall be initiated.

2. Transfer to the emergency standby power source shall take place 2-60 seconds (minimum; adjustable) after attainment of 90% of rated voltage and frequency of that source.

F. When the normal power source has been restored to 90% of rated voltage and less than 10% voltage imbalance, and after a time delay adjustable from 0-30 minutes

(minimum; to ensure the integrity of the normal power source), the load shall be retransferred to the normal source.

G. Upon disconnecting from either source, the transfer switch shall be capable of switching to a neutral position for a user specified time delay of 0-120 seconds, minimum, to allow spinning motors to come to coast to a full stop and VFD control voltage to completely discharge before connecting to the alternate source.

H. A time delay, adjustable 0-10 minutes (minimum), shall delay shutdown of the emergency/standby power source after retransfer to allow the generator to run unloaded for cool-down, after which the generator shall be automatically shut down.

I. If the emergency/standby power source should fail while carrying the load, transfer to the normal power source shall be made instantaneously upon restoration of the normal source to satisfactory conditions.

J. The following features/accessories shall be provided:

1. Auto/test switch to provide test operation of the automatic transfer switch by simulating a loss of the normal power source.

2. Pilot lights to indicate to which source the load is connected.

3. Pilot lights to indicate that an integral overcurrent protective device has tripped.

4. “Dry” Form C relay contacts for monitoring the switch position (both “normal” and “standby” sources). Contacts to be rated 10A (minimum) at 30VDC or 120VAC. Use of interposing relays to provide multiple contacts and/or ratings is permitted.

5. Plant exerciser timer providing automatic test operation of the emergency/standby power source at pre-selected intervals at least once per week, including a selector switch to select exercise with or without load or a bypass of the exercise period. The clock timer shall be provided with a digital readout and include a lithium battery backup to assure continuity of power to the clock timer for a minimum of 72 hours during an outage.

K. Installation of all transfer switch equipment specified herein shall be in accordance with all applicable codes, standards, and practices. Installation of all transfer switch equipment specified herein shall be in accordance with the recommendations of the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. Install equipment and materials in a neat and workmanlike manner and align, level, and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance, and repair.

3.2 SUPPORTS

A. Provide hangers or other devices such as pads, anchors, etc., necessary for the support of the equipment.

B. Provide anchorage according to manufacturer’s written instructions, unless otherwise indicated.

3.3 INSTALLATION

A. Material and Equipment Installation: Follow manufacturer’s installation instructions explicitly, unless otherwise directed. Wherever any conflict arises between manufacturer’s instructions and these Contract Documents, follow Engineer’s direction, at no additional cost to the Owner. Keep copy of manufacturer’s instructions on the job site available for review at all times.

B. The generator set supplier shall install the load bank on the generator prior to delivery to the installation site.

C. The Contractor shall be responsible and shall provide for the supply, installation adjustment, and startup of complete, coordinated systems, which shall reliably perform the specified functions.

D. Maintain minimum workspace around components according to manufacturer’s Shop Drawings and National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise installation and connection of the generator-set unit and to report results in writing.

B. Supervised Adjusting and Pretesting: Under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using a variable resistive load bank simulating kW of loads for which unit is rated.

3.5 TESTING AND STARTUP

A. The following shall be provided:

1. The manufacturer shall provide a certified copy of a 4-hour full-load factory test of a prototype engine-generator unit of the same size as the one being provided with recordings of voltage, frequency, amperage, engine temperature, lube oil pressure, and load transfer results to the Engineer.

2. The actual generator unit shall be field tested with all standby loads picked up and operated for a minimum period of 4 hours. One electronic PDF copy of the test results shall be provided to the Engineer. This testing is to be accomplished only after control system startup and verification to ensure only the correct load is brought online with the generator in operation.

3.6 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.7 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's maintenance personnel as specified below.

1. Conduct a minimum of 8 hours of training as specified in Division 1 Section "Contract Closeout."

2. Schedule training with at least 7 days' advance notice.

3.8 SPARE PARTS

A. Provide the following spare parts for each generator unit:

1. Three sets fuel oil filter elements and gaskets.
2. Three lubricating oil filter elements and gaskets.
3. One air cleaner filter element.
4. Two sets packing for each auxiliary pump.
5. Two sets V-belts for pump drives.

END OF SECTION

SECTION 26 43 13 - TRANSIENT VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.1 SUMMARY

A. Related Sections:

1. Drawings and General Contract Provisions.

1.2 SUBMITTALS

A. Submit all related TVSS Specifications, Drawings, maintenance manuals, installation instructions, and UL 1449, second edition, listed surge suppression ratings of specified protection modes.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: ISO-9001 certification or TVSS manufacturer's complete quality control and documentation procedures of firms regularly engaged in the manufacture of TVSS product for Category-C3 (ANSI/IEEE C62.41) and whose product has been of satisfactory service for not less than 5 years.

1. Provide local support for the TVSS.

2. Provide both the service entrance and distribution panel TVSS of the same manufacturer.

1.4 CODES AND STANDARDS

A. Listed per UL 1449, second edition, and complimentary listed per UL 1283 as an RFI/EMI filter

B. Comply with ANSI/IEEE C62.45 test procedures for Category-C3 established in C62.41 (1991) and CSA certified (C22.2).

C. Comply with NEMA as applicable to construction and NEC 280 for installation and NEC 110.9/110.10 for overcurrent protection.

PART 2 PRODUCTS

2.1 TVSS - MODULAR TYPE

A. List TVSS in accordance with UL 1449 (second edition), Standard for Safety, Transient Voltage Surge Suppressors, and UL 1283, Electromagnetic Interference Filters.

B. Independently test TVSS with the Category-C3 high exposure waveform (20KV - 1.2/50 µs, 10 kA - 8/20 µs) per ANSI/IEEE C62.41.

C. Provide TVSS with copper bus bars (electrical grade copper 1.5-inch wide, 0.25-inch thick) for the surge current path. Small gauge round wiring, plug-in type connections, or printed circuit boards shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.

D. Construct TVSS using field replaceable surge current diversion modules (MOV based). Each module fused with user replaceable 200,000 AIC rated fuses. Monitor the status of each module and indicate on the front of the TVSS's enclosure as well as on each module.

E. Encapsulated TVSS, whether modular or chase nipple units, shall utilize an encapsulant that is UL listed and holds a 94-V2 fire retardant rating. Allow no encapsulant compounds that incorporate epoxy.

F. Provide redundant suppression modules between each phase conductor and neutral, and between the neutral conductor and ground.

G. Equip TVSS with an audible alarm that shall activate when one of the surge current modules have failed. Provide an alarm on/off switch to silence the alarm. Provide an alarm push-to-test switch to test the alarm. Locate the switches and alarm on the front cover of the TVSS's enclosure.

H. TVSS shall Meet or Exceed the Following Criteria:

1. Maximum Single Impulse Current Rating: No less than 120kA per phase. Manufacturers must provide documented proof of independent third party verification of single impulse current withstand capabilities.

2. Pulse Life Test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category-C3 transients without failure or degradation of UL 1449, second edition, clamp voltage by more than 10 percent.

3. The UL 1449, second edition, clamping voltage shall not exceed the following:

a. VOLTAGE L-N N-G

b. 120/208V 400V 400V
c. 277/480V 800V 800V

4. The ANSI/IEEE C62.41-1991 Category-C3 clamping voltage shall not exceed the following:

a. VOLTAGE L-N N-G
b. 120/208V 470V 470V
c. 277/480V 920V 920

I. Provide a response time that is no greater than one nanosecond for any of the individual protection modes.

J. Provide TVSS designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115 percent of nominal RMS voltage.

1. Provide visible indication of proper TVSS connection and operation. The indicator lights shall indicate which phase as well as which module is fully operable.

2. Provide terminals for the necessary power and ground connections. Each terminal shall accommodate wire sizes of 8AWG to 1AWG.

3. Provide TVSS with a minimum EFI/RFI filtering of 34dB at 100KHZ with an insertion loss ratio of 50:1 using Military Standard 220A methodology.

4. Provide TVSS with a 5 year warranty, incorporating unlimited replacement parts if they are destroyed by transients during the warranty period.

5. Equip the TVSS with the Following Items:

a. Provide a connector along with dry contacts (normally open or normally closed) to allow connection to a remote monitoring system.

b. The output of the dry contacts shall indicate a failure of a phase or the entire unit.

K. Manufacturers: Advanced Protection Technologies HPS Series, Cutler-Hammer, Liebert Interceptor Series, Leviton 5700 Series, EFI ISE Series, Lea International, or approved.

PART 3 EXECUTION

3.1 SERVICE ENTRANCE

A. Install TVSS on the load side of the service entrance as directed by manufacturer's installation instructions. Provide 3-pole breaker for disconnect in service entrance equipment, size breaker to manufacturers installation instructions.

B. Install one primary TVSS at each utility service entrance to the facility, according to manufacturer's recommendations.

C. Keep conductors between TVSS and point of attachment short and straight, size conductors per manufacturer's installation instructions.

D. Bond the TVSS's ground to the service entrance ground.

END OF SECTION

SECTION 26 50 00 - LIGHTING

PART 1 GENERAL

1.1 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

B. This section covers the work necessary to furnish and install and complete the electrical lighting system.

1.2 GENERAL

A. See Division 1 and Section 26 05 00, ELECTRICAL GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are necessary for this project.

1.3 SUBMITTALS AFTER AWARD OF CONTRACT

A. Submittals after award of Contract shall be made in accordance with Division 1 and Section 26 05 00 ELECTRICAL GENERAL REQUIREMENTS.

1.4 QUALITY ASSURANCE

A. The Contractor shall test all lighting installations and demonstrate satisfactory operation of switching controls upon completion of the installation. The Contractor shall replace all defective lamps and/or ballasts/drivers prior to occupancy by the Owner. All luminaires shall be cleaned, and visible labels removed.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Refer to the drawings. The Contractor shall be responsible for the complete equipment of all luminaire types. All standard luminaires shall be approved by UL and shall have UL inspecting labels attached thereto. Luminaires shall be grounded in accordance with the NEC.

2.2 LED LUMINAIRES

A. General:

1. LED luminaires shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.

2. LED luminaires shall be Reduction of Hazardous Substances (RoHS)-compliant.

3. LED drivers shall include the following features unless otherwise indicated:

a. Field replaceable.

b. Indoors: 0-10V low voltage dimming.

c. Minimum efficiency: 85% at full load.

d. Minimum Operating Ambient Temperature: -20°C. (-4°F.)

e. Input Voltage: 120V (±10%) at 60 Hz.

f. Integral short circuit, open circuit, and overload protection.

g. Surge protection rated to meet ANSI category 2 for indoors, category C low for outdoors, and shall be field replaceable.

h. Power Factor: ≥ 0.95.

i. Total Harmonic Distortion: ≤ 20%.

j. Comply with FCC 47 CFR Part 15.

4. LED modules shall include the following features unless otherwise indicated:

a. Comply with IES LM-79 and LM-80 requirements.

b. Minimum CRI 80 and color temperature 4000°K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.

c. Minimum Rated Life: 100,000 hours per IES L70 and TM-21 with 70% rated lumen output at 40°C, ambient.

d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. Housing, LED driver, and LED module shall be products of the same manufacturer.

2.3 ACCESSORIES

A. Luminaires shall be furnished complete with all lenses, trims, hangers, nipples, and extensions necessary for a complete installation. All light diffusing media shall be free of scratches or cracks. In general, diffusers shall be of acrylic material unless otherwise noted.

PART 3 EXECUTION

3.1 COORDINATION

A. Verification of Conditions: Verify ceiling construction, recessing depth and other construction details prior to release of luminaires for shipment. Refer cases of uncertain applicability to Engineer for resolution prior to release of luminaires for shipment.

B. Provide all lighting to comply with appropriate location.

3.2 INSTALLATION

A. Install luminaire in accordance with manufacturer's written instructions and with recognized industry practices; to ensure that luminaires comply with requirements and serve intended purposes.

B. Align, mount and level luminaires uniformly. Use ball hangers for suspended stem mounted luminaires.

C. Avoid interference with and provide clearance for equipment. Where intended locations for luminaires conflict with locations of equipment, change locations for luminaire by minimum distance necessary.

D. Suspended Luminaires: Mounting heights indicate clearances between bottom of luminaire and finished floors. Unless otherwise shown, suspension mounting type shall be chain, cable, or stem (Contractor’s option).

E. Supports:

1. Luminaires 48 inches or longer shall not be supported from outlet box ears.

2. Anchor supports to structural slab or to structural members within a partition, or above a suspended ceiling.

3. Support luminaires without causing ceiling or partition to deflect.

4. All recessed luminaires shall be installed using support brackets, grounds, plaster frames, etc. as recommended by the luminaire manufacturer. All supports for

luminaires shall be furnished. All stem lengths shall be adjusted to meet conditions. Mounting heights to bottom of luminaires are given as accurately as possible and shall be adjusted to conform to job conditions.

5. Clean all luminaire lenses prior to final acceptance. Maintain luminaire positions after cleaning and/or replacing/repairing.

6. The Contractor shall provide adequate luminaire attachment to ceiling members in accordance with NEC. The Contractor shall inspect the mechanical plans and the actual site to verify that no interferences occur with diffusers, grills, or duct work.

F. Grounding: Lighting system shall be securely grounded. For rigid conduit, a threaded hub or double locknut and bushing connection shall be considered adequate. For system employing flexible conduit feeds, a green insulated No. 12 AWG solid wire shall be run with the phase conductors and bonded to the box and luminaire at each end of the flexible conduit. The ground connection shall be accomplished by means of cadmium plated round head machine screws, lock washer, and nut.

G. Prior to final acceptance, replace or repair luminaires which have failed.

3.3 ADJUSTING

A. Focus and adjust floodlights, spotlights, and other adjustable luminaires, with Owner's Representative, at such time of day or night as required.

3.4 CLEANING

A. Clean paint splatters, dirt, dust, fingerprints, and debris from luminaires.

B. Where finish of luminaires has been damaged, touch up finish as directed by manufacturer's instructions.

END OF SECTION

SECTION 31 05 13 - SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.

B. Section includes:

1. Subsoil materials
2. Topsoil materials

1.2 RELATED SECTIONS

A. Section 31 05 16 - Aggregates for Earthwork
B. Section 31 10 00 – Site Clearing
C. Section 31 22 13 - Rough Grading
D. Section 31 23 16 – Excavation
E. Section 31 23 17 - Trenching
F. Section 31 23 18 – Rock Removal
G. Section 31 23 23 - Fill
H. Section 31 37 00 - Riprap

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials source.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish materials of each type from same source throughout the Work.

B. Soil Testing:

1. Soil sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. Frequency of testing shall be determined by the Engineer.

3. All soil testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698 (AASHTO T99).

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1, Select Native Material:

1. Select earth obtained from on-site excavations approved for use by Engineer.

2. Graded.

3. Free of peat, humus, vegetative matter, organic matter and rocks larger than 6 inches in diameter.

4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

B. Subsoil Type S2, Imported Fill Material:

1. Imported earth approved for use by Engineer.
2. Meeting the requirements of Subsoil Type S1.

2.2 TOPSOIL MATERIALS

A. Topsoil Type TS1, Select Native Topsoil Material:

1. Top 6 - 12 inches of existing soil containing organic matter.

2. Engineer decision shall be final as to determination of what material is topsoil quality.

3. Graded.

4. Free of roots, rocks larger than 1/2-inch subsoil, debris, large weeds, and foreign matter.

a. Screening: Single screened.

B. Topsoil Type TS2, Imported Topsoil Material:

1. Imported borrow.

2. Friable loam.

3. Reasonably free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds, and foreign matter.

a. Screening: Single screened.

4. Acidity range (pH) of 5-1/2 to 7-1/2.

5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

2.3 SPOILS

A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Engineer.

B. Make arrangements for disposal of the material at no additional cost to the Owner.

C. Landfill permit to be obtained by the Contractor and provided to Engineer prior to commencement of disposal.

2.4 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698 (AASHTO T99).

B. When tests indicate materials do not meet specified requirements, change material or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

C. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.

B. Site within clearing limits shall be stripped of topsoil as required to obtain additional topsoil necessary to complete Work indicated in the Drawings or as specified.

C. When practical, do not excavate wet topsoil.

D. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

E. Remove excess excavated subsoil and topsoil not intended for reuse from Site.

F. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from Site.

3.2 STOCKPILING

A. Stockpile soils at locations shown in the Drawings or at locations as approved by Engineer for redistribution as specified.

1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.

2. No additional payments will be made for stockpiling excavated materials off-site.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes a range of coarse and fine aggregate materials intended to be referenced by other Sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other Sections and in Drawing notes.

B. Section Includes:

1. Coarse aggregate materials
2. Fine aggregate materials

1.2 RELATED SECTIONS

A. Section 31 05 13 - Soils for Earthwork
B. Section 31 22 13 - Rough Grading
C. Section 31 23 17 - Trenching
D. Section 31 23 19 - Dewatering
E. Section 31 23 23 - Fill
F. Section 31 37 00 - Riprap
G. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses

2. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates

3. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

4. AASHTO TP61 - Standard Method of Test for Determining the Percentage of Fracture in Coarse Aggregate

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Aggregate Testing:

1. Aggregate sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. The frequency of testing shall be determined by the Engineer.

3. All aggregate testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by AASHTO T99.

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Aggregate Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1, Dense-Graded Aggregate: Crushed rock with ¾-inch-0, 1-inch-0, 1-1/2-inch-0, 2-inch-0 and 2-1/2-inch-0 gradation as shown in the Drawings and meeting the requirements provided below.

1. Grading - Dense-graded base aggregate shall be crushed rock, including sand. Uniformly grade the aggregates from coarse to fine.

2. Sieve analysis shall be determined according to AASHTO T27.

3. The aggregates shall conform to one of the grading requirements Table 31 05 16-A below.

Table 31 05 16-A
Grading Requirements for Dense-Graded Aggregate
Separated Sizes
Percent Passing (by weight)

Sieve Size	2-1/2" - 0	2" - 0	1-1/2" - 0	1" - 0	3/4" - 0
3”	100				
2-1/2”	95 - 100	100			
2”	-	95 - 100	100		
1-1/2"	-	-	95 - 100	100	
1-1/4”	55 - 75	-	-	-	
1”	-	55 - 75	-	90 - 100	100
3/4"	-	-	55 - 75	-	90 - 100
1/2"	-	-	-	55 - 75	-
3/8”	-	-	-	-	55 - 75
1/4"	30 - 45	30 - 45	35 - 50	40 - 55	40 - 60
No. 4*	-	-	-	-	-
No. 10	[1]	[1]	[1]	[1]	[1]

[1] Of the fraction passing the 1/4-inch sieve, 40 percent to 60 percent shall pass the No. 10 sieve.
* Report percent passing sieve when no grading requirements are listed.

4. Fracture of Rounded Rock:

a. Determined according to AASHTO TP61.

b. Provide at least one fractured face based on the following percentage of particles retained on the 1/4-inch sieve for the designated size:

Minimum Percent of Fractured Particles
by Weight of Material

Designated Size	Retained on 1/4-Inch Sieve
1-1/2-inch – 0 and larger	50
Smaller than 1-1/2-inch – 0	70

5. Durability:

   a. Crushed rock aggregate shall meet the following durability requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	35.0 percent maximum
Degradation (Coarse Aggregate)	ODOT TM 208	30.0 percent maximum
Passing No. 20 Sieve, Sediment Height	ODOT TM 208	3.0-inch maximum

6. Sand Equivalent -- Crushed rock aggregate will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 50.

B. Coarse Aggregate Type A2, Granular Drain Backfill Material: Crushed or uncrushed rock or gravel as shown in the Drawings.

1. Material shall be clean and free draining.
2. Sieve analysis shall be according to AASHTO T27.
3. Grading: Meeting the gradation requirements provided in Table 31 05 16-B below.

Table 31 05 16-B
Grading Requirements for Granular Drain Backfill Material
Separated Sizes
Percent Passing (by weight)

Sieve Size	Separated Sizes 1-1/2-inch – 3/4-inch	Separated Sizes 3/4-inch – 1/2-inch
2-inch	100	
1-1/2-inch	90 - 100	
1-inch	20 - 55	100
3/4-inch	0 - 15	85 - 100
1/2-inch	-	0 - 15
3/8-inch	0 - 5	-

2.2 SAND

A. Sand: Sand material shall consist of granular material, naturally produced or produced from crushed gravel, or dredge sand that is reasonably free of organic material, mica, clay, fly ash, and other deleterious material, meeting the gradations of Table 31 05 16-C below.

Table 31 05 16-C
Grading Requirements for Sand
Separated Sizes
Percent Passing (by weight)

Sieve Size	Coarse Sand	Medium Sand	Fine Sand
1-inch	100	100	100
3/8-inch	95 - 100	95 - 100	-
#4	80 - 100	70 - 95	90 - 100
#30	10 - 30	10 - 45	-
#100	-	2 - 10	2 - 10
#200	0 - 8	0 - 7	0 - 4
Sand Equivalent	50 min.	50 min.	50 in.

2.3 SOURCE QUALITY CONTROL

A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136 and AASHTO T99

B. Sand - Testing and Analysis: Perform in accordance with ASTM C136 and AASHTO T99.

C. When tests indicate materials do not meet specified requirements, change material and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials imported to site as shown in the Drawings or at locations as approved by Engineer for redistribution as specified.

B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

C. Prevent intermixing of aggregate types or contamination.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes clearing site of incidental paving and curbs, debris, grass, trees, and other plant life in preparation for site or building excavation work.

1.2 RELATED SECTIONS:

A. Section 01 56 39 – Temporary Tree and Plant Protection
B. Section 02 41 00 - Demolition
C. Section 31 22 13 - Rough Grading
D. Section 31 23 18 - Rock Removal

1.3 DEFINITIONS

A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.

C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

D. Limits of Disturbance: Work area boundary as shown on the Plans.

E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.

F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Clearing, Grubbing, and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing, and stripping activities at Site.

C. Certification or disposal permit for landfill and/or waste disposal site.

D. A copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

1.5 QUALITY ASSURANCE

A. Existing Conditions: Determine the extent of Work required and limitations before proceeding with Work.

B. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.

C. Conform to applicable local, state, and federal codes for environmental requirements and disposal of debris,

1. Burning on project site will not be permitted.
2. Use of herbicides will not be permitted.

D. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.

E. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of laborers, other persons, and property in the vicinity of the work and requirements of the General Provisions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or specifications.

B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown in approved Clearing, Grubbing, and Stripping Plan.

B. Remain within the property lines at all times.

C. Do not injure or deface vegetation or structures that are not designated for removal.

3.2 EXAMINATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify waste and salvage areas for placing removed materials.

3.3 PREPARATION

A. Carefully coordinate the work of this Section with all other work and construction.

B. Call Local Utility Line Information service at 1-800-332-2344, not less than three working days before performing Work.

C. Request underground utilities to be located and marked within and surrounding construction areas.

1. Disconnect or arrange for disconnection of utilities (if any) affected by required work.

2. Keep all active utilities intact and in continuous operations.

D. Prepare Site only after:

1. Erosion and sediment controls are in place.

a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with COP Erosion and Sediment Control Manual and ESC Permits.

2. Tree and vegetation protection is installed.

a. Protect existing site improvements, trees, and shrubs to remain to preclude damage during construction.

b. Follow the provisions set forth in 01 56 39, Temporary Tree and Plant Protection for all temporary tree and plant protection measures.

3. Temporary fencing is installed along the Limits of Disturbance.

4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

3.4 PROTECTION

A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.

B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.

C. Preservation and Trimming of Trees, Shrubs, and Other Vegetation:

1. Avoid injury to trees, shrubs, vines, plants, grasses, and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.

2. Protect existing trees and shrubs against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction materials, excavated materials, excess foot or vehicular traffic, and parking of vehicles within drip line.

3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.

4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

5. Provide protection for roots and limbs over 1-1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.

6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Engineer. Cost shall be borne by the Contractor.

D. Landscaped Areas:

1. When any portion of the Work crosses private property or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.

2. Conduct Work in a manner that will restore original conditions as nearly as practicable.

3. Remove and replace any trees, shrubs, plants, sod, or other vegetative material as needed to complete Work.

4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.

5. Wherever sod cannot be saved and restored, the ground must be reseeded and cared for until a stand of grass is reestablished.

6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.

7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.

E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, and curbs.

F. Repair and Replacement:

1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

3.5 LIMITS

A. As follows, but not to extend beyond Limits of Disturbance and within the approved disturbance limits:

1. Excavation: 5 feet beyond top of cut slopes.

2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.

3. Fill:

a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
b. Stripping: 2 feet beyond toe of permanent fill.

4. Structures: 15 feet outside of new structures.

5. Roadways: Clearing, grubbing, scalping, and stripping 5 feet from roadway shoulders.

6. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling shall not be permitted without written approval of Owner.

3.6 CLEARING AND GRUBBING

A. Clear and grub areas within limits shown in approved Clearing, Grubbing, and Stripping Plan.

B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.

C. Clearing:

1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds, and other vegetative growth within the clearing limits shown in the Drawings, except those trees and shrubs noted to remain in the Drawings or as directed by the Engineer.

2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the project site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.

3. Clear undergrowth and deadwood, without disturbing subsoil.

D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to the following depths:

1. Future Structures and Building Areas	24 Inches
2. Roads and Parking Areas	18 Inches
3. All other Areas	12 Inches

3.7 TREE REMOVAL

A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.

B. Tree Salvage: As shown on the Plans.

C. No trees may be removed unless approved and permitted by the Engineer.

D. Do not top trees unless otherwise specified or approved by Owner in writing.

E. Refer to Section 01 56 39, Temporary Tree and Plant Protection for tree protection requirements.

3.8 REMOVAL AND DISPOSAL

A. Native vegetation may be mulched and used on Site.

B. Asphalt and Gravel Surfaces:

1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.

2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Engineer.

3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.

C. Remove debris, rock, abandoned piping, and extracted plant life from Site.

D. Remove from the Site all debris, materials, equipment, and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.

1. All existing improvements designated on the Drawings or specified to be removed including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the Work.

2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on site. Leave site in clean condition.

G. Removal: All material resulting from demolition, clearing and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, and debris.

I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

3.9 CLEANUP

A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.

B. All refuse, broken pipe, excess fill material, cribbing, and debris shall be removed as soon as practicable.

C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Engineer.

D. The Work will not be considered complete or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Engineer.

END OF SECTION

SECTION 31 22 13 - ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes rough grading and filling associated with contouring of Site in preparation for building excavation and subsequent site work.

B. Section Includes:

1. Excavating topsoil
2. Excavating subsoil
3. Cutting, grading, filling, and rough contouring of Site

1.2 RELATED SECTIONS:

A. Section 01 45 00 - Quality Control
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 10 00 - Site Clearing
E. Section 31 23 16 - Excavation
F. Section 31 23 17 - Trenching
G. Section 31 23 18 - Rock Removal
H. Section 31 23 23 - Fill

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)

5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Soils for Earthwork: As specified in Section 31 05 13, Soils for Earthwork.
C. Aggregates for Earthwork: As specified in Section 31 05 16, Aggregates for Earthwork.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 PRODUCTS

2.1 MATERIALS

A. Subsoil Fill: Type S1 and S2 as specified in Section 31 05 13, Soils for Earthwork.

B. Topsoil: As specified in Section 31 05 13, Soils for Earthwork.

1. Type TS1, Select Native Topsoil Material, as may be available.
2. TS2, Imported Topsoil Material, as may be required.

C. Structural Fill: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

D. Drain Rock: Type A2, Granular Drain Backfill Material as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than 3 working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Notify Engineer of any potential conflicts resulting from utility locations and the Drawings.

3. Notify utility company to remove and relocate utilities, as may be necessary.

B. Identify required lines, levels, contours, and datum.

C. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with the Work of this Section.

3.3 TOPSOIL EXCAVATION

A. Excavate and stockpile topsoil as specified in Section 31 05 13, Soils for Earthwork.

3.4 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded as shown in the Drawings.

B. When practical, do not excavate wet subsoil. When wet subsoil must be excavated and is to be reused on site for the Work, process wet material to obtain optimum moisture content.

C. Stockpile excavated material in area designated onsite in accordance with Section 31 05 13, Soils for Earthwork.

D. When excavating through roots, perform Work by hand and cut roots with sharp axe.

E. Benching Slopes: Horizontally bench existing slopes greater than 1:2 to key placed fill material to slope to provide firm bearing.

F. Stability: Replace damaged or displaced subsoil as specified for fill.

3.5 FILLING

A. General:

1. Grading and filling operations shall not take place when weather conditions and moisture content of fill materials prevent the attainment of specified density.

2. Vertical curves or roundings at abrupt changes in slope shall be established as approved by Engineer.

3. Bring all graded areas to a relatively smooth, even grade and slope by blading or dragging. Remove high spots and fill depressions.

B. Fill areas to contours and elevations shown in the Drawings with unfrozen materials.

C. Topsoil Fill:

1. Scarify prepared subgrade to depth of 4 inches immediately prior to placing topsoil.

2. Place topsoil in areas to be seeded to depths indicated in the Drawings, minimum depth of 6 inches.

3. Place topsoil material loose; do not compact, do not place in wet or muddy conditions.

D. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 8 inches compacted depth.
2. Structural Fill: Maximum 12 inches compacted depth.
3. Granular Fill: Maximum 12 inches compacted depth.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise.

G. Make grade changes gradual. Blend slope into level areas.

H. Repair or replace items indicated in the Drawings to remain which are damaged by excavation or filling. All costs shall be borne by the Contractor.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 of a foot from required elevation.

3.7 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

B. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922
2. Moisture Tests: ASTM D3017

C. Frequency and location of testing is dependent upon type of material placed. See Section 01 45 00, Quality Control for testing requirements.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.

B. Section Includes:

1. Excavating for building foundations
2. Excavating for paving, roads, and parking areas
3. Excavating for slabs-on-grade
4. Excavating for site structures
5. Excavating for landscaping

1.2 RELATED SECTIONS

1. Section 01 45 00 - Quality Control
2. Section 02 41 00 - Demolition
3. Section 31 05 13 - Soils for Earthwork
4. Section 31 05 16 - Aggregates for Earthwork
5. Section 31 10 00 - Site Clearing
6. Section 31 22 13 - Rough Grading
7. Section 31 23 17 - Trenching
8. Section 31 23 18 - Rock Removal
9. Section 31 23 19 - Dewatering
10. Section 31 23 23 - Fill
11. Section 31 50 00 - Excavation Support and Protection

1.3 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition, or condition of the material encountered. Common Excavation shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation, unless provided as Rock for under Section 31 23 18, Rock Removal below.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.

C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.

D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.

E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.

F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory excavation, for the purposes of locating an underground utility and to investigate underground conditions.

G. Rock Removal: As defined in Section 31 23 18, Rock Removal.

H. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.

I. Unsuitable Materials: See Spoils.

1.4 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.

2. Proposed onsite and off-site spoil disposal locations.

3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner's access to Owner's facilities impacted by excavation Work.

5. Proposed haul routes.

B. Excavation support plan and utility protection plan as specified in Section 31 50 00, Excavation Support and Protection.

1.6 QUALITY ASSURANCE

A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

B. Provide adequate survey control to avoid unauthorized over-excavation.

C. Weather Limitations:

1. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit (F) shall not be used as fill or backfill until material completely thaws.

2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Engineer as to the nature and extent of the differing conditions.

B. Call Local Utility Line Information service at 1-800-332-2344 not less than 3 working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

C. Identify required lines, levels, contours, and datum.

D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 EXISTING UNDERGROUND UTILITIES

A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.

B. Remove inactive or abandoned utilities from within the project grading limits in accordance with Section 33 11 50, Existing Pipe Abandonment.

C. For sewer and other miscellaneous drainage facilities, fill and plug pipes as follows:

1. General:

    a. Remove all structures to a minimum of 3 feet below subgrade, unless otherwise noted.

    b. Cover top surface of all abandoned structures with two sheets of nonwoven geotextile, extended at least 1-foot beyond the outside walls of the abandoned manhole, sump, or basin.

    c. Plug all abandoned pipes with permanent plugs as specified in Section 33 11 50, Existing Pipe Abandonment.

2. Sumps:

    a. Remove existing sediment, soil, and water. Properly dispose of these materials in accordance with the requirements of these specifications.

    b. Remove top cone and first solid concrete section to a depth of approximately 8 to 10 feet below ground.

    c. Fill sump with CLSM.

d. Backfill remaining voids for facilities within existing or proposed roadways with approved materials meeting the requirements of Section 32 11 23, Aggregate Base Courses.

3. Salvaging Manhole Frames, Covers, and Grates:

a. Remove manhole frames, covers, and grates scheduled for salvage and store in approved location.

b. Frames, grates, and covers meeting Specifications may be salvaged from structures to be adjusted and may be reused in the Work if of suitable size and condition.

c. Replace, at no additional cost to the Owner, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.

d. Clean salvaged components to be reused of foreign material by methods that will not harm the components.

4. Existing Manhole Frames and Covers: Manhole frames and covers removed by the Contractor are the property of the Owner. Notify the Engineer a minimum of 48 hours before removal to arrange for pickup of the removed frames and covers, if not reused.

3.4 PRESERVATION OF EXISTING IMPROVEMENTS

A. Protect adjacent existing structures which may be damaged by excavation work.

1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.

2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Engineer.

3. Do not interfere with 45 degree bearing splay of foundations unless approved by the Engineer

4. Excavated material shall not be placed adjacent to existing or proposed structures.

3.5 EXCAVATION

A. General:

1. Method of excavation shall be the Contractor's option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.

2. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Engineer at no additional cost to Owner.

3. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.

4. Provide all measures to ensure public safety.

B. Control of Water:

1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.

2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.

3. Grade top perimeter of excavation to prevent surface water from draining into excavation.

4. See additional requirements in Section 31 23 19, Dewatering.

C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.

D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.

1. Allow for forms, shoring, working space, granular base, topsoil, and similar items, wherever applicable.

2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.

E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.

1. Fill:

a. Subsoil Type S1, Select Native Fill, as approved for use by Engineer.

2. Spoils:

    a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.

    b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.

    c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Engineer.

F. Shoring:

    1. As specified in Section 31 50 00, Excavation Support and Protection.

    1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state, and federal laws, codes, and ordinances.

    2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain, and remove such supports in accordance with applicable ordinances and safety requirements.

    3. The design, planning, installation, and removal of all sheeting accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.

G. Slope existing banks with machine to angle of repose or less until shored.

    1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

    2. Protection of excavation side slopes:

        a. Use excavation methods that will not shatter or loosen excavation slopes.

        b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.

        c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.

d. Excavation in rock or rocky cuts:

1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.

2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.

3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.

e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.

3. Construct slopes free of all exposed roots.

4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.

5. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

6. Trim all surfaces neatly and smoothly.

H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 17, Trenching and Section 31 23 23, Fill.

I. Notify Engineer of unexpected subsurface conditions.

J. Over-excavation for Unsuitable Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.

2. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2-inch – 0 gradation, as specified in Table 31 05 16-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

3. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.

K. Rock Removal:

1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.

2. Remove larger boulders and rock material as specified in Section 31 23 18, Rock Removal.

3. Concrete removal, as defined herein, shall be treated as Rock Removal.

L. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

3.6 FIELD QUALITY CONTROL

A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.

B. Coordinate the visual inspection and approval of all bearing surfaces by Engineer before installing subsequent work.

3.7 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.

B. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17 - TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for excavation and backfill of all utilities, including installation of pipe bedding, pipe zone backfill, trench backfill, and related Work as shown on the Drawings and as specified.

B. Section includes:

1. Excavating trenches for pipe, utility vaults, and other utilities.
2. Compacted fill from top of utility bedding to final grades.
3. Trench and utility vault backfilling and compaction.

C. Related Sections

1. Section 01 45 00 - Quality Control
2. Section 03 30 00 - Cast-In-Place Concrete
3. Section 31 05 13 - Soils for Earthwork
4. Section 31 05 16 - Aggregates for Earthwork
5. Section 31 10 00 - Site Clearing
6. Section 31 22 13 - Rough Grading
7. Section 31 23 16 - Excavation
8. Section 31 23 18 - Rock Removal
9. Section 31 23 23 - Fill
10. Section 31 23 24 - Flowable Fill
11. Section 31 37 00 - Riprap
12. Section 33 31 10 - Sanitary Utility Sewerage Piping
13. Section 33 41 10 - Storm Utility Drainage Piping

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

5. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.3 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill. Lean cement concrete fill. A self-compacting, cementitious material.

B. Flexible Pipe: For the purposes of these Specifications, tubing between 1/2-inch and 4-inch diameter constructed of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) are considered flexible pipes. HDPE piping 4 inches in diameter and larger is also considered flexible pipe.

C. Geosynthetics: Geotextiles, geogrids, geomembranes, and drainage composite materials.

D. Imported Material: Materials obtained from sources offsite, suitable for specified use.

E. Lift: Loose (uncompacted) layer of material.

F. Obstructions: Items which may be encountered during utility and vault trenching which do not require replacement.

G. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

H. Pipe Bedding: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 6 inches below the bottom outside surface of pipe, conduit, cable, or duct bank to the trench foundation so as to uniformly support the barrel of the pipe.

I. Pipe Zone: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 12 inches above the top outside surface of pipe, conduit, cable, or duct bank.

J. Pipe Bedding, Pipe Zone, and Trench Backfill Classifications:

1. Class A: Backfill with suitable native or imported material that is approved to meet the characteristics required for the specific surface loading or other criteria of the backfill zone.

2. Class B: Backfill with imported granular material consisting of gravel or crushed rock meeting the requirements of this Section and Coarse Aggregate Type A1 as specified in Section 31 05 16, Aggregates for Earthwork; typical designated size shall be 1-inch-0 or 3/4-inch-0.

3. Class C: Backfill with Fine Sand, as specified in Section 31 05 16, Aggregates for Earthwork.

4. Class D: Backfill with approved pit run or bar run material, well-graded from coarse to fine; maximum dimension shall be 3 inches.

5. Class E: Backfill with CLSM. See Section 31 23 24, Flowable Fill.

K. Pothole Excavations: Removal and replacement of all materials via coring, vacuum extraction, or similar method for the purposes of locating an underground utility and to investigate underground conditions.

L. Prepared Trench Bottom: The bottom of the trench on which the pipe bedding is to lie and which provides support for the pipe.

M. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM Standards.

N. Rigid Pipe: For the purposes of these Specifications, pipe constructed of PVC, ductile iron, steel, concrete, and clay pipes are considered rigid pipes.

O. Sewer, Pipes, and Mains: Conduits of circular or other geometric shapes, used to convey liquids or gases, or other material.

P. Trench Backfill: Trench backfill zone for full trench width extending from the top of the pipe zone to pavement base rock, ground surface, or other surface material.

Q. Trench Stabilization: Removal of unsuitable material in the bottom of a trench and replacement with specified material for support of a pipe, main, conduit, structure, or appurtenances.

R. Utility: Any buried pipe, duct, conduit, or cable.

S. Well-Graded: A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.4 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.

2. Proposed on-site and off-site spoil disposal locations.

3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner’s access to Owner’s facilities impacted by excavation Work.

5. Proposed haul routes.

B. Excavation support plan and utility protection plan as specified in Section 31 50 00, Excavation Support and Protection.

C. Product Data:

1. Geotextile fabric, indicating fabric and construction
2. Marking tapes
3. Tracer wire
4. Connectors for tracer wire and/or marking tapes
5. Tracer wire locate boxes
6. Marker balls
7. Locator stations
8. Ground wires
9. Plastic or copper markers for service laterals.

D. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

E. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

F. Concrete: Mix designs in accordance with Submittal requirements of Section 03 30 00, Cast-in-Place Concrete.

1.5 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

1.6 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

B. Coordinate trenching and utility installation work with other work at utility construction location occurring near or adjacent to specified herein.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Native Backfill: Type S1, Select Native Material as specified in Section 31 05 13, Soils for Earthwork.

B. Trench Backfill and Pipe Zone Material: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 pounds per square inch (psi).

2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete with compressive strength of 3,000 psi.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Sand: As specified in Section 31 05 16, Aggregates for Earthwork.

F. Trench Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.

2. Foil Thickness: Minimum 0.35 mils.

3. Laminate Thickness: Minimum 5 mils.

4. Width: 6 inches.

5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

7. Manufacturers and Products:

a. Reef Industries; Terra Tape, Sentry Line Detectable
b. Mutual Industries; Detectable Tape
c. Presco; Detectable Tape

B. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities and as specified in NEMA Z535.1, Safety Color Code.

Color	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

2.3 ELECTRONIC LOCATING MATERIALS

A. Marker Balls:

1. Exterior Material: High-density polyethylene.

2. Size: Maximum 4-1/2 inches in diameter.

3. Range: Locatable with standard electronic marker locating devices at depths up to 5 feet.

4. Field Type: Spherical RF field regardless of orientation.

5. Contain no floating or movable parts, and no batteries or active components.

6. Color: Provide colored marker balls per Article 2.03 B above.

7. Manufacturer and Product: Omni Marker Model 162 (green), Omni Marker Model 161 (blue), or approved equal.

B. Tracer Wire:

1. Direct burial No. 12 AWG solid, annealed copper-clad steel (CCS) high strength tracer wire.

2. Tensile Breaking Load: 380-pound average.

3. Jacket:

   a. High molecular weight high-density polyethylene complying with ASTM D1248, 30-volt rating.

   b. Color: Provide in colors per Article 2.03 B above.

4. Manufacturer and Product: Copperhead Industries; LLC, 12 CCS high strength reinforced tracer wire, or approved equal.

C. Tracer Wire Connectors:

1. Waterproof, corrosion proof and suitable for No. 12 AWG solid core wire.

2. Prefilled with silicone and suitable for use with low-voltage tracer lines of less than 50 volts.

3. Lug Connectors:

   a. Waterproof plastic housing that encases the silicone prefilled lug terminals.
   b. Manufacturer and Product: King Innovations; DryConnTM Direct Bury Lug or approved equal.

4. Twist Connectors:

   a. Waterproof epoxy-filled packaging that encases the silicone prefilled twist connectors.

b. Manufacturer and Product: 3M Division; DBY Direct Bury Splice Kit 09053 connectors or approved equal.

D. Ground Wire: No. 12 AWG bare solid copper wire.

E. Locator Station:

1. Test Station:

a. Lexan® polycarbonate.
b. Color: Provide in colors per Article 2.03 B above.

2. Terminals suitable for No. 12 AWG leads.

3. Use single (two lead) locator stations with two terminals, one for ground wire and one for tracer wire, when only one tracer wire is terminated in manhole.

4. Use multi-lead locator stations with the appropriate number of terminals when 2 or more tracer wire leads are terminated in manhole.

5. Manufacturer and Product: Cott Manufacturing Company; FlangeFink® Cathodic Protection Test Station.

2.4 VISUAL IDENTIFICATION MATERIALS

A. Tracer Wire Locate Boxes:

1. Material: Polyolefin.

2. Cover:

a. Color: Provide in colors per Article 2.03 B above.

b. Provide box cover identification marking for facility type such as “Sewer Locate Wire”, as approved by Owner.

c. Locking type with a nominal 6-inch opening.

3. Manufacturer and Product: Carson Industries LLC; L Series Model 708 or approved equal.

B. Service Lateral Plastic or Copper Markers:

1. Service Lateral Plastic or Copper Markers: Use markers of the type that requires installation to be recessed below grade.

a. Material: Plastic or copper. In new concrete, use “new construction” markers; in existing concrete use “retrofit” markers and use adhesive recommended by the manufacturer.

b. Plastic Pavement Markers:

1) UV stabilized and fade resistant.

2) Material: Meet or exceed a tensile strength of 3,500 psi, and meet test requirements as outlined in ASTM G53, Standard Practice for Light and Water Exposure of Nonmetallic Material.

3) Color: Provide in color per Article 2.03 B above with the words, “WARNING, BURIED [UTILITY TYPE], Call Before You Dig,” molded to the top of marker.

a) Provide wording for specific facility as approved by Owner.

4) Manufacturer and Product: Rhino Marking and Protective Systems; A-TAG pavement markers or approved equal.

c. Copper Pavement Markers:

1) Material: Copper material chosen by manufacturer.

2) Diameter: 1-5/32-inch.

3) Wording: Provide facility identification wording stamped on the top such as “Sewer Lateral” as approved by Owner.

4) Manufacturer and Product: Berntsen Concrete Marker; BP2-U or approved equal.

C. Service Lateral 2-inch by 4-inch Markers:

1. S4S Douglas fir, pressure-treated 2-inch by 4-inch lumber, utility grade or better.
2. Grade stamped by an American Lumber Standards certified inspection agency.

PART 3 EXECUTION

3.1 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

3. Maintain and protect above and below grade utilities indicated to remain.

B. Identify required lines, levels, contours, and datum locations.

C. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

D. The site of an open cut excavation shall be first cleared of all obstructions preparatory to excavation in accordance with Section 31 10 00, Site Clearing.

E. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

1. Intent of Drawings and Specifications is that all streets, structures, and utilities be left in condition equal to or better than original condition.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material, which is satisfactory to Owner.

F. Potholing / Exploratory Test Pits: Dig such exploratory test pits and perform potholing as may be necessary in advance of trenching to determine the exact location and elevation of subsurface structures, pipelines, duct banks, conduits, and other obstructions which are likely to be encountered or need to be connected to and shall make acceptable provision for their protection, support, and maintenance of their continued operation.

G. Paved or Surfaced Streets:

1. Wherever paved or surfaced streets are cut, saw wheel or approved cutting devices shall be used.

2. Width of pavement cut shall be as shown in the Drawings.

3. Any cut or broken pavement shall be removed from site during excavation.

H. Traffic:

1. Maintain street traffic at all times as required by the Drawings and as specified herein.

2. Erect and maintain barricades, warning signs, traffic cones, and other safety devices during construction in accordance with the latest edition of Manual of

Uniform Traffic Control Devices (MUTCD), Part 6, to protect the traveling public in any area applicable.

3. Provide flaggers as required during active work in roadway areas.

I. Operations shall be confined to rights-of-way and easements provided. Avoid encroachment on, or damage to, private property or existing utilities unless prior arrangements have been made with copy of said arrangement submitted to Engineer.

3.2 EASEMENTS

A. Where portions of the Work are located on private property, easements and permits will be obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements.

B. Copies of these easements and permits will be available from the Owner for inspection by the Contractor. It shall be the Contractor's responsibility to determine the adequacy of the easement obtained in every case.

C. Confine construction operations to within the easement limits or street right-of-way limits or make special arrangements with the property owners for the additional area required and notify the Engineer with a copy of the written approval from property owners of any such conditions.

D. Any damage to private property, either inside or outside the limits of right-of-way or easements provided by the Owner, resulting from Work shall be the responsibility of the Contractor. Before the Engineer will authorize final payment, the Contractor will be required to furnish the Owner with written releases from property owners where the Contractor has obtained special agreements or easements or where the Contractor's operations, for any reason, have not been kept within the construction right-of-way obtained by the Owner.

3.3 PROTECTION

A. Existing Facilities:

1. It is the intent of these specifications that all streets, structure, and utilities be left in a condition equal to or better than original condition at the completion of the Project.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material to the satisfaction to the Engineer.

3. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

B. Removal of Water:

1. As specified in Section 31 23 19, Dewatering.

2. At all times during construction provide and maintain ample means and devices with which to remove promptly and dispose of properly all water entering the excavations or other parts of the Work.

3. Keep all excavations dry until the utilities or vaults to be placed therein are completed. In water bearing sand, well points and/or sheeting shall be supplied, together with pumps and other appurtenances of ample capacity to keep the excavation dry as specified.

4. Dispose of water from the Work in a suitable legal manner without damage to adjacent property or structures.

C. Trench Protection:

1. Provide the materials, labor, and equipment necessary to protect trenches at all times.

2. Trench protection shall provide safe working conditions in the trench and protect the Work, existing property, utilities, pavement, etc.

3. The method of protection shall be according to the Contractor's design.

4. The Contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided the method meets the approval of all applicable local, state, and federal safety codes.

5. Damages resulting from improper shoring, improper removal of shoring, or from failure to shore shall be the sole responsibility of the Contractor.

3.4 LINES AND GRADES

A. Trench excavation for piping, utility vaults, and other utilities shall be performed to the alignment and grade as indicated in the Drawings.

B. Where grades are not shown in the Drawings, utilities shall be laid to grade between control elevations shown.

C. Water mains shall be installed with a minimum cover of 36 inches.

D. The Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

E. Changes in the grade and horizontal alignment of the pipeline as shown in the Drawings or as provided elsewhere in the Specifications may be necessary due to unanticipated interferences or other reasons.

1. No additional compensation will be allowed the Contractor for changes in horizontal alignment.

2. No additional compensation will be allowed for changes in grade which require additional depth of trench excavation and backfill up to 2 feet from those shown in the Drawings.

F. Use laser-beam instrument with qualified operator to establish lines and grades.

3.5 OBSTRUCTIONS

A. Obstructions to the construction of the trench, such as tree roots, stumps, abandoned pilings, abandoned buildings and concrete structures, logs, rubbish, and debris of all types shall be removed without additional compensation from the Owner.

B. The Engineer may, if requested by the Contractor or Owner, make changes in the trench alignment to avoid major obstructions if such alignment changes can be made within the perpetual easement and right-of-way and without adversely affecting the intended function of the facility or increasing costs to the Owner.

3.6 INTERFERING ROADWAYS AND STRUCTURES

A. Remove, replace and/or repair any damage done during trenching activities to fences, buildings, cultivated fields, drainage crossings, and any other properties without additional compensation from the Owner.

1. Replace or repair these structures to a condition as good as or better than their pre-construction condition prior to commencing work in the area.

B. Paved Roadways:

1. Where paved roadways are cut as part of trenching activities, Class D trench backfill will be required to the bottom of pavement base.

2. New pavement shall be equal to or better than the existing paved surface.

3. New surface shall not deviate by more than 1/4-inch from the existing finish elevation.

C. Existing Structures:

1. If existing structures are encountered as part of trenching activities which will prevent construction and are not adequately shown in the Drawings, the Contractor shall notify the Engineer before continuing with the Work.

2. The Engineer may make such field revisions to the utility alignment as necessary to avoid conflict with the existing conditions.

3. The cost of waiting or "down time" during such field revisions shall be borne by the Contractor without additional cost to the Owner or liability to the Engineer.

4. If the Contactor fails to so notify the Engineer when a conflict of this nature is encountered, but proceeds with construction despite this interference, the Contractor shall do so at the Contractor's own risk with no additional payment.

3.7 TRENCHING

A. Excavate subsoil as required for construction of utilities to elevations shown in the Drawings.

B. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section. Remove larger boulders and rock material as specified in Section 31 23 18, Rock Removal.

C. Open Trench Limit:

1. Do not advance open trench beyond the distance which will be backfilled and compacted the same day.

2. A maximum length of open trench shall not exceed 100 feet at any one time.

3. Temporary resurfacing shall be completed within 300 feet of the associated open trench limit for each main pipe laying operation.

4. Cover or backfill excavations at the end of each day.

5. If the trench is not backfilled at the end of each working day:

a. Provide means to prevent caving of excavation sides, as necessary, during non-working hours.

b. Cover the excavation with a system as needed to provide public safety and prevention of entry during non-working hours.

c. Provide signed and stamped submittal of caving prevention system and cover system.

6. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

D. Utility Crossings: Avoid horizontal and vertical conflicts with existing utilities.

1. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.

2. Vertical clearance between the new pipe and existing utilities shall be 12 inches minimum, unless otherwise noted on the Drawings.

3. Where existing utility lines are damaged or broken during trenching activities, the utility shall be repaired or replaced. For water or sewer bearing lines, care being taken to insure a smooth flow line and absolutely no leakage at the new joints.

4. All expenses involved in the repair or replacement of leaking or broken utility lines that have occurred due to the Contractor's operations shall be borne by the Contractor, and the amount thereof shall be absorbed in the unit prices of its bid.

E. Water Lines Crossing Sewer Lines: Whenever water lines cross sewer lines, the Contractor shall comply with local Health Department requirements.

1. Wherever possible, the bottom of the water line shall be 18 inches or more above the top of sewer pipe. One full length of the water line pipe shall be centered at the crossing.

2. For clearances less than 1-1/2 feet, the Contractor shall replace the existing sewer pipe with ductile iron or PVC of equal size, centered at the utility crossing, or shall encase existing sewer pipe with concrete for a minimum of 10 feet on both sides of crossing, as directed by the Engineer, at no additional cost to the Owner.

F. Excavate trenches to width and depth as indicated on Drawings. No additional payment will be provided for trenching activities beyond dimensions shown in the Drawings.

1. Excavation for trenches in which pipelines are to be installed shall provide adequate space for workers to place and joint the pipe properly and safely, but in every case the trench shall be kept to a minimum width.

2. The width of the pipe trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall not exceed 12 inches on either side of the pipe.

3. Excavation for utility vaults and other structures shall be wide enough to provide 18 inches between the structure surface and the sides of the excavation.

4. For pipe or utility vaults to have bedding material, excavate to a depth of 6 inches below the bottom of the pipe or utility vault. Care shall be taken not to excavate below depths required.

5. If over digging occurs, the trench bottom shall be filled to grade with compacted bedding material.

G. Remove water or materials that interfere with Work.

1. The trench at all times shall be kept free from water to facilitate fine grading, the proper laying and joining of pipe, and prevention of damage to completed joints.

2. Adequate pumping equipment shall be provided to handle and dispose of the water without damage to adjacent property.

3. Water in the trench shall not be allowed to flow through the pipe while construction work is in progress unless special permission to do so has been given by the Engineer.

4. An adequate screen shall be provided to prevent the entrance of objectionable material into the pipe.

5. Remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the improvements.

   a. Where the excavation activities require the removal of portions of an abandoned pipeline, masonry plugs shall be installed in the open ends of the pipe, unless otherwise noted in the Drawings or by the Engineer.

   b. Coordinate with Engineer prior to plugging.

   c. For plugs less than 36 inches in diameter, 8-inch deep masonry units shall be used. For plugs in larger pipelines, 12-inch deep masonry units shall be used.

6. The costs associated with the removal of water and materials noted above will be considered incidental to trench excavation and backfill.

H. Do not interfere with 45 degree bearing splay of foundations.

I. Over-excavation for Unsuitable Trench Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.

2. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.

3. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2-inch – 0 gradation, as specified in Table 31 05 16-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

4. Install nonwoven geotextile under trench stabilization material, over the soft or yielding excavated surface.

    a. Install the nonwoven geotextile ahead of placement of the trench stabilization material, continuously along the excavation bottom and centered on the pipe centerline.

    b. Use nonwoven geotextile width equal to the pipe diameter plus 2 feet.

    c. Place laps or splices in the geotextile in the direction of the pipe laying.

J. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

K. Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic or interfere with the function of existing drainage facilities or system operation.

L. Remove excess subsoil not intended for reuse from site.

M. Stockpile excavated material in area designated on site in accordance with Section 31 05 13, Soils for Earthwork.

3.8 TUNNELING

A. In lieu of open cut trenching as specified above, the Contractor may utilize tunnel methods for installation of pipe where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.

1. The Engineer must approve tunneling methods prior to utility installation.

2. Where tunneling is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks, and other surface improvements whose replacement is avoided by the tunneling method.

3.9 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, new and existing structures, and adjacent and neighboring properties and to prevent caving, erosion, settlement, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

E. Design sheeting and shoring to be removed at completion of excavation work, unless shown otherwise in the Drawings.

F. Construction Sheeting Left in Place:

1. Furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.

2. Construction sheeting and bracing originally intended for temporary installation, placed by the Contractor to protect adjacent and neighboring structures, may be left in place if desired by the Contractor and approved by the Engineer. All such sheeting and bracing left in place shall be included in the cost for excavation.

3. Any construction sheeting and bracing which the Contractor has placed to facilitate its work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating an obligation on its part to issue such orders. Failure of the Engineer to order sheeting and bracing left in place shall not relieve the Contractor of its responsibility under the contract.

4. For sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.

3.10 COMPACTION

A. Testing will be required to show specified densities of compacted backfill are being achieved by the Contractor’s compaction methods.

B. Moisture Control:

1. Moisture condition backfill material to within 2 percent of optimum moisture content required for compaction throughout each lift of the fill.

2. Add moisture to granular backfill by sprinkling during compaction operation.

3. Compaction by ponding or jetting is not permitted.

C. Compact all materials and areas that are not accessible for in-place density testing, as determined by the Engineer, in place by whatever equipment and method is practicable or specified, and as approved by the Engineer.

1. Perform compaction at such moisture content as is required to produce well-filled, dense, and firm material in place that will show no appreciable deflection or reaction under the compacting equipment.

3.11 BEDDING

A. All utility vaults, potable water pipe 4-inch nominal diameter and over, all steel pipe, all concrete sewer pipe, all plastic pipe, all pipe under existing or future structures or roadways, and any and all utilities at a depth greater than 6 feet shall be laid in pipe bedding material.

B. Unless otherwise noted in the Drawings, pipe or conduit of less than 4-inch diameter, outside structure lines and at a depth of less than 6 feet shall be bedded in native material properly shaped as specified below, all as detailed on the Drawings.

C. Compacted bedding material shall be placed the full width of the excavated trench to a depth as shown on the trench detail included in the Drawings.

1. In lieu of a detail, the depth shall be 6 inches.

D. Spread the bedding smoothly over entire width of trench to the proper grade so that the pipe is uniformly supported along the barrel.

E. Hand grade and compact each lift to provide a firm, unyielding surface along the entire pipe length. For rigid pipe, compact to at least 90 percent relative compaction.

F. Excavate bell holes at each joint to permit proper assembly and inspection of the joint.

G. Check grade and correct irregularities in bedding material.

H. Center pipes horizontally in trench width.

3.12 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Maintain optimum moisture content of fill materials to attain required compaction density.

D. Place fill material, with the exception of CLSM, in continuous layers and compact in 6- to 8-inch lifts.

1. Prevent pipe from moving either horizontally or vertically during placement and compaction of pipe zone material.

2. Where trenches are under existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on the Drawings or specified elsewhere in these specifications, the trench backfill shall be Class B or Class E and pipe zone backfill shall be Class B or Class E. Class B backfill shall be compacted to 95 percent of maximum density at optimum moisture content.

3. Where trenches are outside existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on plans or specified elsewhere, the trench backfill shall be Class A and pipe zone backfill in these areas shall be Class B. For these locations, compaction of Class B backfill shall be to not less than 90 percent of maximum density at optimum moisture content. Class B backfill shall be compacted to not less than 95 percent of maximum density at optimum moisture content.

E. Employ placement method that does not disturb or damage nearby or adjacent foundation perimeter drainage or utilities in trench.

F. Do not use power-driven impact compactors to compact pipe zone material.

G. Backfill Immediately: All trenches and excavations shall be backfilled immediately after pipe or conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible, unless otherwise directed by the Engineer.

H. Under no circumstances shall water be permitted to rise in open trenches after pipe has been placed.

I. Do not allow backfill material to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.

J. Use hand compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

K. Placement of Sand:

1. Place medium sand in lifts not exceeding 8 inches in uncompacted thickness.

2. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

L. Placement of CLSM:

1. Discharge from truck-mounted drum-type mixer into trench.

2. Place in lifts not exceeding 2 feet in thickness.

3. No compaction of CLSM is allowed.

4. Use steel plates to protect the CLSM from traffic a minimum of 24 hours. After 24 hours, the CLSM may be paved, or opened to traffic until permanent surface restoration is completed, if it has hardened sufficiently to prevent rutting.

M. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

N. Do not leave trench open at end of working day.

3.13 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, install 24 inches below finished grade. Coordinate with piping installation drawings.

3.14 ELECTRONIC LOCATING FACILITY INSTALLATION

A. Marker Balls:

1. Install according to manufacturer's recommendations and as shown or directed and according to the following requirements:

a. Install marker balls directly above the pipe alignment at a depth no less than 3 feet and no more than 4-1/2 feet below final surface grade.

b. Install marker balls during trench backfill operations by placing the marker ball in compacted backfill.

c. Cover marker ball with a minimum of 6 inches of backfill and compact backfill before continuing trench backfill operations.

d. Install markers balls with trenchless pipe installations by core-drilling hole of a minimal diameter needed to allow clearance for placement of marker ball.

Backfill with approved trench backfill, pavement base and pavement, as applicable.

2. Water Marker Ball Locations: Install at locations as required by Sewer Marker Ball Locations specified herein.

3. Sewer Marker Ball Locations:

   a. Install marker balls directly above connection points, termination points and all fitting locations, and at a minimum spacing of 50 linear feet on sewers with a straight horizontal alignment.

   b. Install marker balls at a minimum spacing of 25 lineal feet directly above sewer mains installed on a radius.

   c. Install marker balls on new or reconstructed sewer service laterals, directly above the centerline of the end of the lateral at the curb, property line or other end of lateral location, as directed.

   d. Install marker balls directly above every alignment change along sewer mains and service laterals.

   e. Install marker balls directly above manholes for manholes with buried covers.

B. Tracer Wire and Terminal Appurtenances:

1. Tracer Wire:

   a. Install as shown or directed directly over the pipe centerline and on top of the pipe zone in all sewer trenches, including mainline sewers, service laterals and storm sewer inlet leads.

   b. Connect mainline and service lateral tracer wires using either an approved direct-bury lug connector or direct-bury twist connector.

   c. Extend tracer wire to locator stations in manholes, locator boxes, storm inlets, or other visually identifiable terminal appurtenances, allowing for access with electronic locating equipment, as shown or directed and according to the following requirements:

2. Locator Stations:

   a. Install locator stations as shown within manholes.

   b. Mount locator station to manhole wall within 18 inches of manhole rim with two stainless steel expansion anchors.

c. Drill a minimum 3/8-inch diameter hole through the manhole wall within 18 inches of the finish grade of the manhole rim.

d. Extend the tracer wire from the pipe trench in one continuous piece up the outside of the manhole and through the hole and into a locator station and attach to one of the lugs in the locator station.

e. When multiple tracer wires are terminated in manhole install a multi-lead locator station.

f. Extend a ground wire from the locator station through a minimum 3/8-inch diameter hole in the manhole wall.

g. Install ground wire approximately 3 feet deep and extend from the outside manhole wall a minimum of 3 feet horizontally in any direction.

h. Seal all holes drilled in manhole walls with silicone sealant.

3. Storm Inlet Tracer Wire Termination: Terminate tracer wire inside inlet and directly over storm outlet pipe by placing tracer wire as follows:

a. Drill a minimum 3/8-inch diameter hole through inlet wall to pass tracer wire through to inside inlet wall.

b. Seal hole with silicon sealer or material approved by Engineer.

c. Leave 6 inches of coiled tracer wire along inside of inlet wall approximately 3 inches below the inlet frame and grate or as directed by Engineer.

4. Service Lateral Tracer Wire Termination: Terminate tracer wire at ends of service laterals as shown or directed, as follows:

a. Termination in Tracer Wire Locate Boxes: Extend the tracer wire in one continuous piece up vertically from the pipe trench and into the bottom of the locate box. Leave 18 inches of coiled tracer wire inside locate box.

b. Termination at 2-inch by 4-inch Markers: Extend tracer wire in one continuous piece directly up service lateral 2-inch by 4-inch markers and leave 18 inches of tracer wire wrapped around the exposed top end of 2-inch by 4-inch marker.

3.15 VISUAL IDENTIFICATION FACILITIES

A. Tracer Wire Locate Boxes: Install tracer wire locate boxes directly over service laterals at property line, service boundary, or other location as shown or directed by the Engineer.

B. Service Lateral Plastic or Copper Markers:

1. Install plastic or copper markers in the concrete curb directly over the centerline of the service lateral, as shown or directed by the Engineer.

2. Either plastic or copper markers may be used.

3. If there is not suitable concrete curb for marker placement, then install a lateral cleanout as close to property line as practical at location approved by Engineer.

C. Service Lateral 2-inch by 4-inch Markers:

1. Place a 2-inch by 4-inch marker at the end of each new service lateral not connected to a building sewer.

2. Omit markers only as approved.

3. Block the capped or plugged service lateral end with a wood block against undisturbed earth and install the marker.

4. Extend the marker from the blocked service lateral invert to at least 12 inches above the existing or proposed finish ground surface.

5. Install marker in one piece. No splicing will be accepted.

6. Paint the exposed portion of the marker after its installation with quality quick drying enamel white paint for a storm only sewer and green paint for a sanitary or combined sewer.

7. After the paint has dried, use black, quick drying enamel, and neatly indicate the distance from the ground surface to the top of the service lateral in feet and inches.

8. Do not disturb the position and location of the marker during the backfilling operation.

9. If the marker is broken, moved out of location, or vertical alignment is changed during the backfilling operation, reopen the trench and replace the marker.

3.16 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory with payment responsibility for initial testing as identified in Specification 01 45 00-Quality Control. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

C. In-place compaction testing of pipeline backfill materials shall be performed at 2-foot elevation increments, one test per 200 lineal feet of pipeline trench as measured along pipe centerline.

1. The Engineer may reduce the frequency when satisfied with method of compaction.

2. The Engineer may direct testing at a higher frequency at no additional cost to the Owner upon failure to obtain specified densities or if the Contractor changes compaction equipment or methods of compaction.

3. The Engineer shall determine all test locations.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922
2. Moisture Tests: ASTM D3017

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

3.17 SURFACE RESTORATION AND CLEANUP

A. Open Trenches: At the end of each workday, all open trenches shall be backfilled and all trenches within streets shall be temporarily paved or covered to the satisfaction of the Engineer and the local permitting agency.

1. Temporary paving shall be replaced with permanent street paving at the completion of construction within street rights-of-way, or sooner, if deemed necessary by the ENGINEER.

2. No gravel-filled trenches shall be left open within the street right-of-way at the end of the workday.

B. Topsoil:

1. Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil to the specified depth and place the material in a stockpile.

2. Topsoil shall not be mixed with other excavated material.

3. After the trench has been backfilled, the topsoil shall be replaced.

C. Clean up and remove all excess materials, construction materials, debris from construction, etc. Replace or repair any fences, mailboxes, signs, landscaping, or other

facilities removed or damaged during construction. Replace all lawns, topsoil, shrubbery, flowers, etc., damaged or removed during construction. The Contractor shall be responsible for seeing that lawns, shrubs, etc. remain alive and leave premises in condition equal to original condition before construction.

END OF SECTION

SECTION 31 23 18 - ROCK REMOVAL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes removal of subsurface rock during excavation by mechanical method. The use of explosives for rock removal is not permitting for this project.

B. Section Includes:

1. Removing identified and discovered rock during excavation.
2. Expansive tools to assist rock removal.

C. Related Sections:

1. Section 31 22 13 - Rough Grading
2. Section 31 23 16 - Excavation: Building excavation
3. Section 31 23 17 - Trenching: Trenching and backfilling for utilities
4. Section 31 23 23 - Fill: Backfill materials
5. Section 31 37 00 - Riprap

1.2 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition, or condition of the material encountered. All excavation shall be classified as Common Excavation, unless provided for under Rock Removal below.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.

C. Rock: Solid mineral material, including boulders, solid bedrock, or ledge rock, with volume in excess of 1/2 cubic yard or solid material which, by actual demonstration, cannot be reasonably excavated with suitable machinery as defined herein. The Engineer may waive the requirements for actual demonstration if the material encountered is well-defined rock.

D. Rock Removal: Removal of rock as defined herein by systematic and continuous drilling, hammering, breaking, splitting, or other methods approved by the Engineer.

E. Suitable Machinery: A track-mounted hydraulic excavator of the 52,800- to 72,500-pound class equipped with a single shank ripper.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate proposed method of rock removal.

C. Equipment: Manufacturer information regarding pound class of machinery proposed for rock removal.

D. Survey Report: Submit survey report mapping extent and locations of rock encountered, to be used in calculating total volume of rock removal.

1.4 PROJECT CONDITIONS

A. Conduct survey of rock uncovered in excavation for structures or trenching for utilities prior to removal of material.

B. Conduct survey and document conditions of buildings near locations of rock removal, prior to blasting, and photograph existing conditions identifying existing irregularities.

C. Advise owners of adjacent buildings or structures in writing, prior to executing seismographic survey. Explain planned blasting and seismic operations.

D. Obtain seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

PART 2 PRODUCTS - Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting Work of this section.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Engineer Approval for Rock Removal:

1. Prior to commencement of rock removal, expose all material anticipated to be rock by removing the common material above it and then notify the Engineer.

2. The Engineer, in association with the Contactor or the Contractor's representative, will measure the amount of material to be removed in an effort to reach a mutually agreeable volume for anticipated rock removal.

3. Prior to commencing the proposed rock removal, the Contractor must receive written approval by the Engineer stating the approximate volume of excepted rock removal to receive payment.

4. During rock removal activities, should it become apparent the previously agreed upon volume of rock removal will be exceeded, notify the Engineer immediately. Should the Contractor proceed with rock removal in excess of the previously agreed upon volume, the Contractor will do so at their own risk and expense.

3.3 ROCK REMOVAL BY MECHANICAL METHOD

A. Excavate and remove rock by mechanical method.

1. Use single shank ripper to fracture rock.
2. Drill holes and use expansive tools and wedges to fracture rock.

B. Cut away rock at bottom of excavation to form level bearing.

C. Remove shaled layers to provide sound and unshattered base for footings and foundations.

D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

E. For vaults and other structures, excavate to the depth necessary to install the structure and to a maximum of 18 inches beyond the outside walls of the vault or structure.

F. Remove excavated materials from site.

G. Correct unauthorized rock removal associated with structural excavations in accordance with backfilling and compacting requirements of Section 31 23 16, Excavation and as directed by Engineer.

H. Correct unauthorized rock removal associated with utility work in accordance with backfilling and compacting requirements of Section 31 23 17, Trenching and as directed by Engineer.

I. If material which would be classified as rock as defined herein is mechanically removed with equipment of a larger size than specified as Suitable Machinery herein, it shall be understood that any added costs for the removal of rock by this method shall be included in the unit price for common excavation and not paid for under this pay item. If material which would be classified as rock as defined herein is mechanically removed

without blasting, hammering, breaking, or splitting, it will be considered common excavation and not paid for under this pay item. If equipment larger than the suitable machinery as defined herein is brought on the project site for the sole purpose of rock removal without hammering, breaking or splitting, then such excavation will be considered rock removal.

3.4 FIELD QUALITY CONTROL

A. Request visual inspection of foundation bearing surfaces by Engineer before installing subsequent work.

END OF SECTION

SECTION 31 23 19 - DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide all labor, materials, and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents.

B. Section includes:

1. Dewatering systems.
2. Surface water control systems.
3. System operation and maintenance.
4. Water disposal.

1.2 RELATED SECTIONS

A. Section 02 30 00 - Subsurface Investigations
B. Section 31 05 16 - Aggregates for Earthwork
C. Section 31 23 16 - Excavation
D. Section 31 23 17 – Trenching
E. Section 31 50 00 – Excavation Support and Protection
F. Section 02 35 00 – Caisson Construction

1.3 THE REQUIREMENT

A. A geotechnical investigation was completed for the project. A report summarizing geotechnical data, findings and recommendations is provided in the Contract Documents as Supplementary Information. The report indicates that groundwater will likely be present during excavation at the Pump Station site, and that control of groundwater through dewatering methods will be necessary.

B. As part of the Work to be furnished under the awarded contract price, the CONTRACTOR shall provide a temporary dewatering system that meets the following performance requirements:

1. At the pump station site, for all excavations exceeding ten feet in depth, construct a system using 4 deep wells to keep the groundwater level at least 2 feet below the level of the excavation bottom, or as required to maintain a stable subgrade.

2. If the existing well is damaged during construction activities the Contractor shall install 1 monitoring well at the pump station site.

1.4 SUBMITTALS

The CONTRACTOR shall submit its plans for dewatering the pump station site and force main and gravity pipe trenches to the ENGINEER for review prior to the beginning of construction activities requiring such systems. No excavations shall be started until the submittal review is complete. Said review by the ENGINEER of the CONTRACTOR's design shall not be construed as a detailed analysis of the adequacy of the dewatering system, nor shall any provisions of the above requirements be construed as relieving the CONTRACTOR of its overall responsibility and liability for the work. Information to be provided with the submittal shall include the following:

A. Design calculations and drawings indicating the location and size of deep wells, observation wells, sumps, discharge lines, sediment control systems and any other groundwater control system component. Calculations and drawings shall be made by an Oregon registered Professional Engineer experienced in the design of dewatering systems.

B. Capacities and details of pumps and standby equipment.

C. Design calculations showing adequacy of system and selected equipment, including well screen slot sizes and filter pack calculations.

D. Detailed description of the dewatering schedule, operation, maintenance and well abandonment procedures.

E. Projected drawdown in wells and estimated zone of influence with groundwater elevations.

F. Estimated dewatering system discharge flow rate.

G. Test method, equipment and schedule for monitoring discharge water quality.

H. Name of Oregon licensed well driller planned for installation and abandonment of dewatering and observation wells.

1.5 DEFINITIONS

A. Dewatering includes the following:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels, and /or shafts.

2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels, and /or shafts.

3. Disposing of removed water.

B. Surface Water Control: Removal of surface water within open excavations.

1.6 QUALITY CONTROL

A. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

B. Secure all necessary permits to complete the requirements of this Section.

C. Control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

D. Where the critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop.

1. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor.

2. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

Dewatering, where required, may include the use of well points, deep wells, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 DEWATERING

A. Provide all equipment necessary for dewatering.

1. Have on hand, at all times, sufficient pumping equipment and machinery in good working condition.

2. Have available, at all times, competent workers for the operation of the pumping equipment.

3. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for the deep excavations at the pump station site, including the wet well and the gravity sewer, shall commence prior to any excavation and shall include installation of the 4 deep wells and 1 monitoring well as described herein. Dewatering shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. Dewatering for pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

D. Site Grading:

1. At all times, site grading shall promote drainage.

2. Surface runoff shall be diverted from excavations.

3. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

E. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

F. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

G. Maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

H. Flotation shall be prevented by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

I. Where deep wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

J. Dispose of water from the work in a suitable manner without damage to the environment or adjacent property. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be filtered using an approved method to remove sand and fine sized soil particles before disposal into any drainage system. Contractor shall have one baker tank on the pump station site for settling and filtering of sediment laden water.

K. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

L. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the work and all costs thereof shall be included in the various contract prices in the bid forms.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes backfilling required at building perimeter and site structures to subgrade elevations, fill under interior and exterior slabs-on-grade or pavement, and fill under landscaped areas. Backfilling for utilities within building proper is included within this section; backfilling for utilities outside building is included in Section 31 23 17, Trenching.

B. Section includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete
B. Section 31 05 13 - Soils for Earthwork
C. Section 31 05 16 - Aggregates for Earthwork
D. Section 31 22 13 - Rough Grading
E. Section 31 23 16 - Excavation
F. Section 31 23 17 - Trenching
G. Section 31 23 24 - Flowable Fill
H. Section 31 37 00 - Riprap
I. Section 33 31 10 - Sanitary Utility Sewerage Piping
J. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

5. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill elsewhere in these Specifications. A self-compacted, cementitious material.

B. Imported Material: Materials obtained from sources offsite, suitable for specified use.

C. Lift: Loose (uncompacted) layer of material.

D. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

C. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.6 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S2, Imported Fill Material, as specified in Section 31 05 13, Soils for Earthwork.

B. Structural Fill and Backfill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 pounds per square inch (psi).

2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete. Compressive strength as required by the application or as noted in the Drawings.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Foundation Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to Work in this Section, become familiar with Site conditions. In the event discrepancies are found, notify Engineer as to the nature and extent of the differing conditions.

B. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.

C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

D. See provisions for Work in Section 31 25 00, Erosion and Sediment Controls.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Control of Water:

1. Excavated areas shall be kept free of water and frost.

2. Bearing surfaces which become softened by water or frost shall be re-excavated to solid bearing at Contractor’s expense and backfilled with compacted crushed rock at Contractor’s expense.

3. See Section 31 23 19, Dewatering for additional details.

C. Compact subgrade to density requirements for subsequent backfill materials.

D. Cut out soft areas of subgrade not capable of compaction in place and replace with specified granular fill material. See Article 3.5, Over-excavation for Unsuitable Foundation Conditions in Section 31 23 16, Excavation for additional details.

E. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

F. Subgrade to be approved by Engineer prior to placement of structures and commencement of backfill activities.

G. Do not allow or cause any work performed or installed to be covered up or enclosed prior to required tests and approvals. Should any Work be enclosed or covered up, uncover at Contractor's expense.

3.4 BACKFILLING

A. Backfill areas to contours and elevations shown in the Drawings with unfrozen materials.

B. Do not place materials when weather conditions and/or moisture content prevent attainment of specified density.

C. Maintain optimum moisture content of backfill materials to attain required compaction density.

D. Employ placement method that does not disturb or damage other work.

E. Mechanical tampers permitted in confined areas.

F. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

G. Foundation Base for Structures:

1. Bring excavation to required subgrade elevation shown in the Drawings.

2. Place foundation base material to required grade shown in the Drawings.

3. Place foundation base material in 6-inch lifts and compact to 95 percent maximum dry density.

4. Pump Station:

a. Concrete Footings: Place a 6-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation to required grade under all concrete footings.

b. Concrete Slabs: Place an 8-inch minimum layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation under all concrete slabs.

5. Foundations established near finished site grades:

a. Place a 3-inch thick layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in the bottom of footing excavations to minimize disturbance of silty foundation soils during wet weather.

b. Lightly compact material with a light-weight hand-operated vibratory plate compactor.

c. To provide uniform support, slabs should be underlain by a minimum 8-inch thick granular base course consisting of 1-1/2- or 3/4-inch - 0 gradation.

d. The base course material should be installed in a single lift and compacted to at least 95 percent of the maximum dry density. See Drawings for details.

H. Backfill for Structures:

1. Prior to placing backfill, remove forms, temporary construction, and debris below grade.

2. Backfill shall not be placed against poured concrete until 28 days have passed from completion of original concrete pour, unless otherwise approved by Engineer.

3. Heavy compactors and large pieces of construction equipment shall be kept away from any embedded wall a distance of a least 5 feet in order to avoid the build-up of excessive lateral pressures.

a. Over-compaction of fill near walls should be avoided.

4. Compaction within 5 feet of the walls shall be accomplished using hand-operated vibratory plate compactors or tamping units.

5. The maximum particle size of granular material placed against buried structures shall be limited to no greater than 1-1/2-inch diameter.

6. Structural fill backfill material shall be brought up on all sides of the walls and footings in such a manner as to avoid adverse differential lateral earth pressures on the vertical surfaces.

7. Appropriate lift thickness will depend on the type of compaction equipment used and the type of material being placed. All material shall be compacted to at least 95 percent of the standard maximum dry density.

    a. For moderate- to heavy-weight compactors, a maximum loose lift thickness of 12 inches shall be used.

    b. For hand-operated or small compactors, a maximum loose lift thickness of 8 inches shall be used.

8. Particular care must be taken to avoid damage to the pipe connections to the structure.

9. Utility trench backfill within 10 feet of all structural perimeters shall meet the requirements for structural fill.

I. For areas receiving surface structures or existing paved areas to be constructed or replaced, such as roadways, driveways, parking lots, and sidewalks:

1. Place Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in 6-inch lifts.

2. Compact with vibratory equipment to 95 percent maximum density, unless otherwise specified or shown in the Drawings.

J. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise in the Drawings.

K. Make gradual grade changes. Blend slope into level areas.

L. Remove surplus backfill materials from Site in accordance with Section 31 23 16, Excavation.

3.5 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by an independent laboratory with payment responsibility for initial testing as identified in Specification 01 45 00-Quality Control. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

C. In-place compaction testing for structural fill material shall be performed at 2-foot elevation increments in the fill material with at a minimum of one test per each 2,500 square feet of material placed. The Engineer shall be provided with the results of each compaction test at the time of testing.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

F. When testing of subgrade is not possible or feasible as detailed above, proof roll compacted fill surfaces under slabs-on-grade, pavers, paving, and as may be otherwise required by the Engineer.

3.6 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

SECTION 31 23 24 - FLOWABLE FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes flowable lean concrete mix used for structure backfill, utility bedding and backfill and other subgrade Site Work. Applications also include filling abandoned structures and utilities that remain in place.

B. Section Includes:

1. Structure backfill
2. Utility bedding
3. Utility backfill
4. Filling abandoned utilities

1.2 RELATED SECTIONS

A. Section 33 11 50 - Existing Pipe Abandonment
B. Section 31 23 16 - Excavation
C. Section 31 23 17 - Trenching
D. Section 31 23 23 – Fill
E. Section 33 31 10 - Sanitary Utility Sewerage Piping
F. Section 33 41 10 - Storm Utility Drainage Piping

1.3 DEFINITIONS

A. Flowable Fill: Also referred to as Controlled Low Strength Material (CLSM) elsewhere in the Specifications. Lean cement concrete fill.

B. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

1.4 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM C33 - Standard Specification for Concrete Aggregates

2. ASTM C94 - Standard Specification for Ready-Mixed Concrete

3. ASTM C150 - Standard Specification for Portland Cement

4. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete

5. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

6. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete

7. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

8. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

9. ASTM C1040 - Standard Test Methods for Density of Unhardened and Hardened Concrete in Place by Nuclear Methods

10. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Field Quality-Control Submittals:

1. Mix Design:

a. Furnish flowable fill mix design for each specified strength.

b. Furnish separate mix designs when admixtures are required for the following:

1) Flowable fill Work during hot and cold weather.
2) Air entrained flowable fill Work.

c. Identify design mix ingredients, proportions, properties, admixtures, and tests.

2. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements.

D. Delivery Tickets:

1. Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.

1.6 QUALITY ASSURANCE

A. In-place testing of Flowable Fill: In accordance with ASTM C403.
B. Compressive testing of Flowable Fill: In accordance with ASTM D4832.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Minimum Conditions: The following minimum conditions shall be met at time of flowable fill placement.

1. Do not install flowable fill during inclement weather.

2. Ambient temperature must be at least 34 degrees Fahrenheit (F) (4 degrees Celsius (C)) and rising.

3. Flowable fill shall be at 40 degrees F (4 degrees C).

4. Subgrade on which flowable fill is to be placed shall be free of disturbed or soft material, debris and water.

1.8 FIELD MEASUREMENTS

A. Verify field measurements before installing flowable fill to establish quantities required to complete the Work.

PART 2 PRODUCTS

2.1 FLOWABLE FILL

A. Flowable Fill:

1. Composed of cement, pozzolans, fine aggregate, water, and admixtures.

2. Low cement content.

3. Non-segregating, self-consolidating, free-flowing, and excavatable material which will result in a hardened, dense, non-settling fill.

4. Compressive strength at 28 days of 100 to 200 pounds per square inch (psi), if not otherwise shown in Drawings or specified.

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type 1 - Normal.
B. Fine Aggregates: ASTM C33.
C. Water: Clean and not detrimental to concrete.

2.3 ADMIXTURES

A. Air Entrainment: ASTM C260.

B. Chemical Admixture: ASTM C494.

1. Type A - Water Reducing
2. Type B - Retarding
3. Type C - Accelerating
4. Type D - Water Reducing and Retarding
5. Type E - Water Reducing and Accelerating
6. Type F - Water Reducing, High Range
7. Type G - Water Reducing, High Range, and Retarding

C. Fly Ash: ASTM C618 Class C or F, obtained from residue of electric generating plant using ground or powdered coal.

D. Plasticizing: ASTM C1017 Type 1, plasticizing.

2.4 MIXES

A. Mix and deliver flowable fill according to ASTM C94, Option C.

B. Flowable Fill Design Mix:

ITEM	PROPERTIES
Cement Content	75 to 100 lb/cu yd
Fly Ash Content	None
Water Content	As specified
Air Entrainment	5 to 35 percent
28-Day Compressive Strength	Maximum 200 psi.
Unit Mass (Wet)	110 [125] pcf
Temperature, Minimum at Point of Delivery	50 degrees F (10 degrees C)

C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.

D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.5 SOURCE QUALITY CONTROL

A. Test and analyze properties of flowable fill design mix and certify results for the following:

1. Design mix proportions by weight of each material.

2. Aggregate: ASTM C33 for material properties and gradation.

3. Properties of plastic flowable fill design mix including:

    a. Temperature
    b. Slump
    c. Air entrainment
    d. Wet unit mass
    e. Yield
    f. Cement factor

4. Properties of hardened flowable fill design mix including:

    a. Compressive strength at 1-day, 7 days, and 28 days. Report compressive strength of each specimen and average specimen compressive strength.

    b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.

B. Prepare delivery tickets containing the following information:

1. Project designation
2. Date
3. Time
4. Class and quantity of flowable fill
5. Actual batch proportions
6. Free moisture content of aggregate
7. Quantity of water withheld

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavation specified in Section 31 23 16, Excavation and trenching specified in Section 31 23 17, Trenching is complete.

B. Verify utility installation as specified in elsewhere in the specifications is complete and tested before placing flowable fill.

C. Verify excavation is dry and dewatering system is operating, as may be required, prior to placement of flowable fill.

3.2 PREPARATION

A. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.

B. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.

C. Protect utilities and foundation drains to prevent intrusion of flowable fill.

3.3 INSTALLATION - FILL, BEDDING, AND BACKFILL

A. Place flowable fill by chute, pumping, or other methods as approved by Engineer.

B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.

C. Place flowable fill evenly on both sides of utilities to maintain alignment.

D. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

3.4 INSTALLATION - FILLING ABANDONED UTILITIES

A. As specified in Section 33 11 50, Existing Pipe Abandonment.

3.5 FIELD QUALITY CONTROL

A. Perform inspection and testing according to ASTM C94.

1. Take samples for tests for every 100 cubic yards of flowable fill, or fraction thereof, installed each day.

2. Sample, prepare, and test four compressive strength test cylinders according to ASTM D4832. Test one specimen at 3 days, one at 7 days, and two at 28 days.

3. Measure temperature at point of delivery when samples are prepared.

B. Further construction proceeding upon placed flowable fill will be permitted only after initial set is attained, as measured by ASTM C 403.

1. Perform in place penetration (density) tests using handheld penetrometer to measure penetration resistance of hardened flowable fill.

2. Perform tests at locations as directed by Engineer.

C. Defective Flowable Fill: The Engineer reserves the right to reject all flowable fill failing to meet the following test requirements or flowable fill delivered without the following documentation.

1. Test Requirements:

a. Minimum temperature at point of delivery.
b. Compressive strength requirements for each type of fill.

2. Documentation: Duplicate delivery tickets.

D. No traffic or construction equipment shall be allowed on flowable fill for a least 24 hours after placement.

3.6 CLEANING

A. Remove spilled and excess flowable fill from Project Site.

B. Restore facilities and Site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION

SECTION 31 37 00 - RIP RAP

PART 1 GENERAL

1.1 SCOPE

This Section consists of furnishing and placing an erosion-resistant cover material for protecting slopes and basins at locations shown or as directed.

1.2 RELATED SECTIONS

A. Section 03 60 00, Grouting
B. Section 31 22 13, Rough Grading
C. Section 31 23 18, Rock Removal

1.3 DEFINITIONS

A. Filter Blanket - A layer of graded granular material placed between the area prepared for it and the riprap.

B. Grouted Riprap - Loose riprap with all or part of the spaces filled with Portland cement mortar.

C. Keyed Riprap - Loose riprap placed on prepared slope, riprap geotextile, or filter blanket, as specified, and keyed in place by slapping the surface with a piece of armor plating.

D. Loose Riprap - Specified classes of graded rock placed on prepared slope, riprap geotextile, or filter blanket, as specified.

E. Riprap Backing - An option of using either riprap geotextile or a filter blanket placed between the area prepared for it and the riprap.

F. Riprap Basin - Energy dissipater consisting of loose riprap placed at pipe outlets as specified.

G. Riprap Geotextile - A geotextile placed between the area prepared for it and the riprap.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

PART 2 MATERIALS

2.1 RIPRAP GEOTEXTILE

A. Furnish riprap geotextile as shown in the Drawings.

2.2 RIPRAP REQUIREMENTS

A. General - Furnish rock for loose riprap meeting the following requirements:

1. Meet the test requirements of provided herein.

2. Be angular in shape. Thickness of a single rock shall not be less than 1/3 its length. Rounded rock will not be accepted unless authorized by the ENGINEER.

3. Meet the gradation requirements for the class specified.

4. Be free from overburden, spoil, shale, and organic material. Non-durable rock, shale, or rock with shale seams is not acceptable.

B. Test Requirements - Furnish the rock meeting the following test requirements:

Material Test	Requirement
Apparent Specific Gravity (AASHTO T 85)	2.50 Min.
% Absorption (AASHTO T 85)	6.0 Max.
Degradation (ODOT TM 208A)	
Passing No. 20 Sieve	35.0% Max.
Sediment Height	8.0" Max.
Soundness (AASHTO T 104)	
Average Loss of 2 1/2" - 1 1/2" and 1 1/2" - 3/4" fraction after 5 alternations	16.0% Max.

C. Gradation Requirements - Grade loose riprap by class and weight of rock according to the following:

Class 50	Class 100	Class 200	Class 700	Class 2000	
		Weight of Rock (pounds)			Percent (by Weight)
50 - 30	100 - 60	200 -	700 -	2000 -	20.0
30 - 15	60 - 25	140	500	1400	30.0
15 - 2	25 - 2	140 - 80	500 -	1400 -	40.0
2 - 0	2 - 0	80 - 8	200	700	10.0 - 0
		8 - 0	200 - 20	700 - 40	
			20 - 0	40 - 0	

Uniformly grade each load of riprap from the smallest to the largest weight specified. Control of gradation will be by visual inspection.

1. Control Sample - If directed, provide, at a satisfactory location near the project site, a rock sample of at least 5 tons meeting the gradation for the class specified. This sample will be used as a frequent visual reference for judging the gradation of the riprap supplied.

2. Sampling and Testing Assistance - Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of rock. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the CONTRACTOR at no additional cost to the OWNER.

D. Grouted Riprap

1. Furnish rock for grouted rip rap meeting the requirements of stated herein for class and size specified.

2. Furnish non-shrink Portland cement grout meeting the requirements of Section 03 60 00, Grouting.

E. Filter Blanket - Furnish filter blanket material meeting the following requirements according to riprap class:

Riprap Class	Filter Blanket
Class 2000	16-inch layer of Class 50 riprap conforming to the requirements of this section
Class 700	9-inch layer of 6-inch - 0 stone embankment meeting the test requirements of this section
Class 200	6-inch layer of 4-inch - 0 stone embankment meeting the test requirements of this section
Class 100	No filter blanket required
Class 50	No filter blanket required

PART 3 EXECUTION

3.1 PREPARATION

A. Remove brush, trees, stumps, and other organic material from slopes to be protected by riprap and dress to a smooth surface.

B. Remove all unsuitable material to the depth shown or directed and replace with approved material.

C. Compact filled areas as specified in Section 31 23 23, Fill.

D. Provide riprap protection as early as the structure foundation construction permits. Prepare the surfaces to be protected as shown.

E. Maintain the trench slopes, riprap geotextile, or filter blanket until the riprap is placed.

3.2 RIPRAP GEOTEXTILE

A. Install riprap geotextile as shown in the Drawings or as directed by the ENGINEER.

3.3 FILTER BLANKET CONSTRUCTION

A. If required, place the filter blanket on the prepared area to the full specified thickness in one operation, using methods which will not cause segregation.

B. The surface of the finished layer shall be reasonably even.

3.4 RIPRAP BACKING

A. When indicated on the Drawings, the CONTRACTOR shall have the option of placing either riprap geotextile or a filter blanket behind the riprap.

B. Install the backing per these specifications or as shown in the Drawings.

3.5 RIPRAP

A. General - Unless otherwise directed, place the riprap protection as the embankment is constructed. Its placement shall lag behind embankment construction only as necessary to allow proper embankment construction and prevent mixture of embankment and riprap material.

B. Loose Riprap - Place riprap on the prepared area:

1. With a clamshell, orange-peel bucket, skip, or similar approved device which will contain the riprap material to its final destination. Do not open the bucket until it has been lowered to the slope on which the material is being placed.

2. To its full course thickness in one operation.

3. According to the compaction requirements of Section 31 23 23, Fill if riprap is placed on geotextile

4. By methods that do not cause segregation of riprap or displace the underlying material.

5. To produce a compact riprap protection in which all sizes of material are placed in their proper proportion.

6. With some hand placing, or rearranging of individual stones by mechanical equipment, or some other approved means to provide a smooth finished surface.

Where filter material and/or riprap are placed under water, increase their thicknesses as shown or as directed.

C. Keyed Riprap - After placing loose riprap material, key the riprap into place by slapping the surface with a piece of armor plating (approximately 4 feet by 5 feet in size with a weight of approximately 5,000 pounds) or other approved means which will produce a nearly smooth surface.

D. Grouted Riprap - Place loose riprap material. If the depth specified for grouting is more than 12 inches, place the riprap in lifts of 12 inches or less and grout each lift before placing the next lift. Construct and grout the succeeding lifts before the grout in the previous lift has hardened.

Thoroughly moisten the stones and sluice any excess fines to the underside of the riprap before grouting. Deliver the grout to the place of final deposit by any means that will ensure uniformity and prevent segregation of the grout. Spade or rod the grout into the spaces to completely fill the voids in the riprap. Control pressure grouting and do not unseat the stones. Penetration of the grout shall be to the depth shown on the plans. If a rough surface is specified, brush the stone until 25 percent to 50 percent of the depth of surface stone is exposed. For a smooth surface, grout the crevices to within 5/8-inch of the surface.

Provide weep holes through the riprap as shown or as directed.

Place and cure grout according to 03 60 00, Grouting, except as provided above.

E. Riprap Basins - Excavate, backfill, and construct riprap basins, without a riprap geotextile or filter blanket, at pipe outlets with Class 50 riprap as shown or as directed.

3.6 MAINTENANCE - maintain the riprap protection until accepted. Replace any material displaced by any cause at no additional cost to the owner.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes shoring and support systems of all types necessary to protect existing utility facilities and to construct new utility facilities.

B. The Contractor is responsible for the selection and design of excavation support systems and the design of utility support systems in conformance with Federal, State, and City requirements and the minimum design criteria specified herein.

C. Care must be taken during the planning and construction of earth support systems to minimize settlements and displacements of the shoring system itself and to surrounding properties.

1.2 RELATED SECTIONS

A. Section 31 23 16, Excavation
B. Section 31 23 17, Trenching
C. Section 31 23 19, Dewatering
D. Section 31 23 23, Fill
E. Section 33 31 10, Sanitary Utility Sewerage Piping
F. Section 33 41 10, Storm Utility Drainage Piping.

1.3 DESIGN CRITERIA

A. Design excavation support systems and all components to support the earth pressures, unrelieved hydrostatic pressures, utility loads, equipment, traffic, railroad, and construction loads including impact, and other surcharge loads in such manner as will allow the safe and expeditious construction of the permanent structures to minimize ground movement or settlement, and to prevent damage to adjacent structures, roadways, railroads, and utilities.

B. Design support members to resist the maximum loads expected to occur during the excavation and support removal stages.

C. Design system so that water seepage is minimized. Provide dewatering and positive means for preventing sloughing and containing material behind lagging.

D. Design system to prevent sloughing and to contain running sand and silt behind the lagging.

E. Vertical support capacity shall be provided for wall systems and internal bracing elements for loads due to vertical force components and live loads on any portion of the system.

F. Design calculations and shop drawings of all excavation support systems.

1. Calculations and shop drawings shall be made and stamped by a registered Professional Civil or Structural Engineer experienced in the design of excavation support systems in the State of Oregon.

2. Comply with the applicable requirements of OSHA and the Oregon Structural Specialty Code with respect to excavation and construction.

1.4 SUBMITTALS

A. Section 01 33 00, Submittals - Submittal Procedures: Requirements for submittals.

B. Excavation Support Systems

1. Plans and details for trench and excavation support systems.

a. Shop drawings and supporting calculations shall meet the specified design criteria requirements and include the following:

1) Arrangement, size, and details for individual excavation support system.

2) Construction methods and sequencing to be used for the installation and removal of each excavation support system.

3) Contingency plan for alternative procedures to be implemented if the excavation support system is found to perform unfavorably or if obstructions are encountered in the installation.

2. Provide for Engineer review prior to the beginning of construction activities requiring such systems.

3. No excavations shall be started until the submittal review is complete.

4. Review by the Engineer of the submitted design shall not be construed as a detailed analysis of the adequacy of the support system, nor shall any provisions of the above requirements be construed as relieving overall responsibility and liability for the work.

C. Excavation Plan

1. Designed to prevent damage to existing and surrounding properties.

D. Settlement Monitoring Plan, to include the following:

1. Detailed location of settlement monitoring points.

2. Reference benchmarks (City and/or County) to be employed.

3. Survey procedures (including name of survey crew leader and equipment to be used).

4. Approach to recording surveyed readings and means of reporting of results to the Owner.

E. Contingency Plan

1. Provide alternative procedures to be implemented if the excavation support systems are found to perform unfavorably or if obstructions are encountered in the installation of excavation support systems.

2. Contingency plan is to demonstrate a preparedness to mitigate the effects of movement or settlement.

3. The following minimum requirements for a contingency plan are:

a. Measures to be taken in order to protect existing facilities and neighboring properties from additional settlement or movement.

b. Identification of all material, manpower, equipment, and other items to be available and onsite at all times while excavations and dewatering activities are ongoing and reasonably after the work has been completed.

F. Site Conditions Survey

1. Videotape surveys, photographs, and other data significant in noting the pre-construction conditions of the existing project site, as well as the pre-construction conditions of the neighboring properties and their existing structures.

2. Provide to the OWNER for record purposes prior to, but not more than 3 weeks before, commencement of any construction activities.

3. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the Owner and Engineer.

1.5 QUALITY ASSURANCE

A. Contractor is solely responsible for quality assurance of temporary shoring.

B. At each excavation support system location, provide the following:

1. Continual verification system is planned, executed, and maintained in accordance with applicable codes, regulations, and good construction practice.

2. Systematic observation of suitability of shoring materials.

3. Installation, excavation, settlement, and lateral deflection monitoring.

4. Groundwater control.

5. Adjacent construction activities.

6. Other factors, as necessary.

C. Continually verify installation of the shoring is in conformance with the plans prepared by the Contractor's design engineers.

1.6 CONTRACTOR QUALIFICATIONS

A. The work of this Section shall be done by a firm specializing in this type of work. The firm shall:

1. Regularly and presently perform shoring installation as one of their principal services.

2. Have technical qualifications, experience, training, and facilities to properly install shoring.

3. Provide the services of a supervising engineer, registered in the State, with at least 5 years of experience in the design and construction of shoring walls.

4. A foreman or superintendent experienced in the installation and removal shoring walls shall be present while this work is performed.

1.7 PERMITTING

A. Secure all permits necessary to complete the requirements of this Section.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be safe and in good condition and shall conform to local, state, and federal codes.

PART 3 EXECUTION

3.1 GENERAL

A. Provide sheeting, shoring, and other protection and support systems wherever required, in accordance with current local, state, and federal laws, codes, and ordinances.

B. The Contractor is solely responsible for excavation protection and worker safety.

C. The Contractor shall be solely responsible for the protection of existing utilities and structures. Under no circumstance shall work threaten the integrity (physical and operational) of these utilities and/or structures.

3.2 EXCAVATION SUPPORT SYSTEMS

A. The excavation support systems shall not disturb the state of soil adjacent to the trench or excavation and below the excavation bottom.

B. Water control measures shall be provided at all times in accordance with the requirements specified in Section 31 23 19, Dewatering.

C. The support system shall extend below the main excavation bottom elevation to a depth adequate to prevent hydrostatic uplift, seepage and piping, and lateral movement and to adequately support applied vertical loads.

D. Damage to existing utilities or structures during installation of excavation support system shall be avoided. If damage occurs, it shall be repaired at no cost to the Owner and to the satisfaction of the utility owner.

E. A company representative from the excavation support system shall be onsite during initial setup of the system. Install excavation support system in strict conformance with the representative's recommendations.

3.3 CONTINGENCY PLAN IMPLEMENTATION

A. Excess movements or settlements: Work shall be stopped immediately and the causes of excess or detrimental movements evaluated if:

1. Damage is noted to existing site features or surrounding properties.

2. Shoring wall movements exceed the limits specified herein or per submitted calculations.

B. Immediately notify the Engineer and begin the implementation of the approved contingency plan to mitigate the effects of settlement or movement occurred.

3.4 REMOVAL OF SUPPORT SYSTEMS

A. Removal of excavation support systems shall be performed in a manner that does not disturb or damage adjacent new or existing structures or utilities.

B. Fill all voids immediately with specified backfill material.

C. All damage to property resulting from removal shall be promptly repaired at no cost to the OWNER. The Engineer shall be the sole judge as to the extent and determination of the methods and materials for repair.

END OF SECTION

SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes construction of an aggregate subbase and base course for placement under asphalt or concrete paving, unit paving, or placed and left exposed.

B. Section Includes:

1. Aggregate subbase
2. Aggregate base course

1.2 RELATED REQUIREMENTS:

A. Section 31 22 13 - Rough Grading
B. Section 31 23 17 - Trenching
C. Section 31 23 23 - Fill
D. Section 31 37 00 - Riprap
E. Section 31 05 16 - Aggregates for Earthwork
F. Section 32 12 16 - Asphalt Concrete Pavement

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications

2. T11, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing

3. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

4. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

1. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

2. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports

5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities and standing water, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Keystone: Fine aggregate used to aid in binding of loose surface stone.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit data for geotextile fabric and herbicide.

C. Materials Source: Submit name of aggregate materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

PART 2 PRODUCTS

2.1 SHOULDER AGGREGATE

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.2 DENSE-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 32 05 16, Aggregates for Earthwork.

2.3 OPEN-GRADED BASE AGGREGATES

A. Of the size shown on the Plans.

B. Coarse Aggregate: Type A2, Granular Drain Backfill Material as specified in Section 32 05 16, Aggregates for Earthwork.

2.4 SOURCE QUALITY CONTROL

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

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

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

2.5 EQUIPMENT

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

2.6 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Obtain Engineer’s acceptance of subgrade before placing base course or surfacing material.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.

1. Proof roll substrate with equipment approved by the Engineer in minimum two perpendicular passes to identify soft spots.

2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.3 HAULING AND SPREADING

A. Hauling Materials:

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

2. Loads: Of uniform capacity.

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

B. Spreading Materials:

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

2. Produce even distribution of material on prepared surface without segregation.

3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

4. Maintain consistent gradation of material. Widely varying gradation will be cause for rejection.

3.4 CONSTRUCTION OF COURSES

A. Untreated Aggregate Base Course:

1. If the required compacted depth of the base course exceeds 6 inches, construct it in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

2. Completed Course Total Thickness: As shown on the Plans, 8-inch minimum.

3. Spread lift on preceding course to required cross-section. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.

4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:

   a. Use 3/4-inch leveling course or surfacing material as keystone.

   b. Spread evenly on top of base course, using spreader boxes or chip spreaders.

   c. Roll surface until keystone is worked into interstices of base course without excessive displacement.

   d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.

6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing and Leveling Course:

1. Place shoulder aggregates in a single layer, or two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 9 inches.

2. Spread on preceding course in accordance with cross-section shown.

3. Blade lightly and roll surface until material is thoroughly compacted.

4. Complete Total Thickness: As shown on the Plans, 8-inch minimum.

3.5 ROLLING AND COMPACTION

A. Commence compaction of each layer of base immediately after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by AASHTO T99.

B. Roll each layer of material until there is no appreciable reaction or yielding under the compactor before succeeding layer is applied.

C. Shape and maintain the surface of each layer during compaction operations. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to the required density before succeeding lift is placed.

F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate: Within plus or minus 0.04-foot of grade shown at any individual point.

C. Overall Average: Within plus or minus 0.04-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

A. Quality control testing shall be performed by an independent testing laboratory provided by the Owner.

B. Refer to table below for minimum sampling and testing requirements for aggregate base course and surfacing. The OWNER reserves the right to complete additional testing.

Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T99	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	AASHTO T310	One for each 500 ton but at least every 10,000 square feet of area	In-place completed, compacted area

3.8 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate. Restore per Specifications as applicable.

END OF SECTION

SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SCOPE

This section includes the construction of asphalt concrete pavement.

1.2 REFERENCE STANDARDS

A. References herein to "AASHTO" shall mean Association of American State Highway Transportation Officials.

B. Standard Specifications: Where the term "Standard Specifications" is used, such reference shall mean the current edition of the Oregon Department of Transportation (ODOT) Standard Specifications for Highway Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.3 DEFINITIONS

A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041 (Rice), by 62.4 pounds per cubic foot.

1.4 SUBMITTALS

A. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00640 for aggregate used in aggregate base.

B. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00745 for aggregate used in asphalt concrete.

C. Job mix formula shall be an approved job mix formula. Submit formula, supplier, and product identification to the Engineer 30 days prior to start.

1. Definite percentage for:

    a. Each sieve fraction.
    b. New asphalt cement.
    c. Recycled asphalt pavement.

2. Temperature of completed mix when discharged from mixer.

3. Character and quantity of anti-strip and recycling agents.

1.5 QUALITY ASSURANCE

A. All testing to determine compliance with the specifications shall be performed by an independent testing laboratory contracted by the Contractor and approved by the Engineer. All testing costs shall be borne by the Contractor.

B. A minimum of five nuclear densometer readings shall be taken in random locations within every test area. Each test area shall not exceed 200 tons of asphalt; however, smaller areas may be designated by the Engineer.

C. The surface smoothness of the new asphalt concrete pavement shall be such that when a 10-foot straightedge is laid longitudinally across the paved area in any direction, the new pavement shall not deviate from the straightedge more than 1/8-inch. Surface drainage shall be maintained. Additionally, paving must conform to the design grade and crown and contain no abrupt edges, low or high areas or any other imperfections as determined by the Engineer. Pavement construction not meeting these requirements will be repaired by grinding the existing pavement to a 1-1/2-inch depth and replacing with Level 3, 1/2-inch dense graded Asphaltic Concrete the full width at no cost to Owner.

1.6 PRE-PAVING CONFERENCE

A. Any supervisory personnel of the Contractor and any subcontractors who are to be involved in the paving work shall meet with the Engineer, at a time mutually agreed upon, to discuss methods of accomplishing all phases of the paving work.

B. The Contractor shall be prepared to review the size and type of equipment to be used and the anticipated rate of placement to determine equipment needs.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIAL

A. Aggregate Base for Dense Graded Asphalt Concrete: The aggregate material shall be a clean, well-graded crushed base aggregate conforming to the Standard Specifications. Base course shall be 1-1/2-inch minus aggregate and leveling course shall be 3/4-inch minus aggregate, unless otherwise shown on the plans.

2.2 ASPHALT CONCRETE PAVEMENT

A. Dense Graded Hot Mix Asphalt Concrete

1. Use Level 3, 1/2-inch-dense graded, PG 70-22 HMAC. Conform to the requirements as specified in Section 00745 of the Standard Specifications. Conform to the requirements as specified in Section 00745 of the Standard Specification.

2. Asphaltic concrete pavement delivered to the site shall be accompanied by a ticket with the approved "job mix formula" number shown. Loads without tickets identifying the job mix formula will not be accepted.

3. Percent of recycled asphalt pavement used in new asphalt pavement shall not exceed 30 percent. Recycled asphalt pavement may not be used in top wearing course unless otherwise approved by the Engineer.

B. Tack Coat

In accordance with Standard Specifications. Use AR 4000, AC-20 asphalt or CSS-1 emulsified asphalt C.

C. Seal and Cover Coat

Asphalt material shall be CRS-2 cationic emulsified asphalt. Cover stone shall conform to size 1/4-inch #10 aggregate in the Standard Specifications.

D. Subgrade Geotextile

1. Dense Graded AC Mix-For subgrade separation using dense graded asphalt concrete, use subgrade geotextile with Certification Level B as specified in Section 02320 of the Standard Specifications.

E. Subgrade Stabilization

In the event that unstable materials are encountered during excavation, the additional excavation and installation of geotextile fabric and 12 inches of rock substructure will be required, as directed. Conform to the requirements as specified in Section 00331 of the Standard Specifications. For subgrade separation, use subgrade geotextile with Certification Level B as specified in Section 02320 of the Standard Specifications.

2.3 WHEEL STOPS

A. Provide 6” wide by 6’ long precast concrete wheel stop.

1. Wheel stop concrete to have a minimum 28 day compressive strength of 4,000 psi.

2. Wheel stop to be designed for H20 loading non-roadway applications.

3. Install per manufacturer's requirements.

4. Manufactured by Oldcastle Infrastructure or approved equal.

PART 3 EXECUTION

3.1 AGGREGATE PAVEMENT BASE

A. Place pavement base to the depth shown on the plans or as specified in all cases, pavement base shall be compacted to a minimum depth of 6 inches. Bring the top of the pavement base to a smooth, even grade at a distance below finished grade equivalent to the required pavement depth.

B. Compact the pavement base with mechanical vibratory or impact tampers to a density of not less than 95 percent of the maximum density, as determined by AASHTO T-99.

C. Obtain the Engineer's acceptance of the subgrade before beginning construction of the aggregate base course.

D. When, in the judgment of the Engineer, the weather is such that satisfactory results cannot be secured, suspend operations. Place no aggregate base course in snow or in soft, muddy, or frozen subgrade.

E. If the required compacted depth of aggregate base course exceeds 6 inches, construct in two or more lifts of approximately equal thickness. Maximum compacted thickness of any one lift shall not exceed 6 inches. Compact each layer to the specified density before a succeeding lift is placed.

3.2 ASPHALT CONCRETE PAVEMENT

A. Construct asphalt concrete pavement in accordance with Section 00745 of the Standard Specifications.

B. Conform to the requirements for prime coat and tack coat in the Standard Specifications. Tack coat all edges of existing pavement, manhole and clean out frames, inlet boxes, and like items. When rate is not specified, asphalt will be applied at the rate of 0.1-gallon per square yard.

C. Obtain the Engineer's acceptance of the aggregate base course before beginning construction of the asphalt concrete wearing course.

D. Hot mix asphalt shall be placed on dry, prepared surfaces, when air temperature in the shade of 40 degrees Fahrenheit (F) or warmer, unless otherwise authorized by the Engineer.

E. Placing asphalt pavement during rain or other adverse weather conditions will not be permitted unless otherwise authorized by the Engineer, except that asphalt mix in transit at the time these adverse conditions occur may be placed provided it is of proper temperature, the mix has been covered during transit, and it is placed on a foundation free from mud or free-standing water.

F. Correct any defects in material and workmanship, as directed, when determined detrimental by the Engineer. These include segregation of materials, non-uniform texture, and fouled surfaces preventing full bond between successive spreads of mixture. The corrections or replacement of defective material or workmanship shall be at the Contractor's expense.

G. Compact the bituminous mixture to at least 92 percent of the Theoretical Maximum Density.

H. The finished surface of each course of layer of mixture shall be of uniform texture, smooth, and free of defects and shall closely parallel that specified for the top surface finished grade. Remove and replace boils and slicks immediately with suitable materials.

I. The surface of each layer when tested with a Contractor-furnished 10-foot straightedge shall not vary from the testing edge by more than 0.02-foot for underlying courses of pavements and 0.015-foot for finished top courses or wearing courses of pavements. At no point shall the finished top of the wearing course vary more than 0.03-foot from the specified finished grade.

J. Lift thickness shall be as shown on the drawings or specified, but not to exceed 3 inches.

K. Do not place asphalt concrete pavement on emulsified asphalt (tack coat) until the asphalt separates from the water (breaks) but before it loses its tackiness.

L. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 FIELD QUALITY CONTROL

A. Job mix will be sampled immediately behind the paving machine.

B. Temperature of the mix will be measured immediately behind the paver.

C. The theoretical maximum specific gravity of the bituminous mixture will be determined in accordance with ASTM D2041.

D. Properties of the job mix will be measured using ASTM D2041.

E. Density of the compacted job mix will be measured in accordance with ASTM D2922.

3.4 ADJUSTMENT OF EXISTING MANHOLE COVERS AND VALVE BOXES

Prior to placing asphalt concrete pavement, the CONTRACTOR shall make all necessary adjustments to existing manhole frames and covers and valve box covers to ensure that the tops of the manhole covers or valve box lids are flush with the finished grade of the adjoining pavement or ground surface, and that valve boxes and PVC pipes are centered and plumb over operating nut valve.

END OF SECTION

SECTION 32 31 13 - CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes chain link steel fencing and gates as shown on the Drawings or specified elsewhere. All fences and gates shall be furnished with top rails and knuckled periphery edges.

B. Section includes:

1. Chain link fabric
2. Posts
3. Rails
4. Tension wires
5. Braces
6. Fittings
7. Gates
8. Lock assemblies and gate stops

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Chain Link Fence Manufacturer's Institute:

1. Galvanized Steel Chain Link Fence Fabric
2. Industrial Steel Specifications for Fence-Posts, Gates and Accessories

B. ASTM International (ASTM):

1. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
2. A313, Standard Specification for Stainless Steel Spring Wire
3. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
4. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
5. A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
6. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
7. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

8. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence

9. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

10. C94, Standard Specification for Ready-Mixed Concrete

11. C150, Standard Specification for Portland Cement

12. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete

13. F552, Standard Terminology Relating to Chain Link Fencing

14. F567, Standard Practice for Installation of Chain-Link Fence

15. F626, Standard Specification for Fence Fittings

16. F900, Standard Specification for Industrial and Commercial Swing Gates

17. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework

18. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

19. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric

20. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates

21. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications

C. Conflicts in requirements shall use this Section to take precedence.

1.3 SUBMITTALS

A. Section 01 30 00, Submittal Procedures: Requirements for submittals.

B. Shop Drawings:

1. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.

2. Fence, gate posts, rails, and fittings.

3. Chain link fabric.

4. Gates and hardware.

C. Manufacturer's recommended installation instructions.

D. Evidence of Supplier and installer qualifications.

1.4 QUALITY ASSURANCE

A. Use skilled workers thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Provide each type of steel fence and gate as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings, and fastenings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition.

B. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 MATERIALS

A. Fabric

1. Continuous chain link fence with 2 13/16-inch slats.

2. Height: As shown on the Drawings.

3. Mesh: 3 1/2-inch by 5-inch. All mesh shall have knuckled periphery to eliminate sharp appendages.

4. #9-gauge steel core wire.

5. Top and bottom selvage: Knuckled finish.

6. Galvanized after weaving.

7. Zinc coating shall not be less than 1.2 ounces per square foot.

8. Fabric shall be provided with powder coating, colored black and slats shall be midnight black.

B. Line Posts

Line posts shall be hot dipped galvanized 2.375-inch outside diameter hot dipped galvanized pipe, weighing 3.12 pounds per lineal foot.

C. Terminal Posts

End, corner, and pull posts shall be hot dipped galvanized pipe 2.875 inches outside diameter and weighing not less than 4.64 pounds per lineal foot.

D. Top Rail

1. Top rail shall be hot dipped galvanized 1.660-inch outside diameter pipe, weighing 1.83 pounds per lineal foot.

2. Furnish in random lengths of approximately 20 feet.

3. Jointed using a pressed steel or malleable sleeve, not only allowing for expansion and contraction, but also providing a continuous brace from end to end of each stretch of fence.

E. Tension Wire

Bottom tension wire shall be #6-gauge heavy galvanized high carbon steel coil spring wire, securely fixed to the fabric, line posts, and terminal posts.

F. Braces

1. All terminal posts shall be braced with 1.660-inch outside diameter. horizontal pipe bracing of the same material as the top rail, securely attached to the terminal and first line post with malleable iron fittings.

2. Braces shall be truss-braced from the first line post to the bottom of the terminal post, with a 3/8-inch galvanized truss rod assembly.

3. Corner posts shall be braced in both directions.

G. Fittings

1. Malleable, cast iron, or pressed steel.
2. Hot dip galvanized.

H. Fabric Ties

1. #11-gauge galvanized wire ties shall be used to tie the fabric to the line posts and rails.

I. Chain Link Gates

1. Frames:

   a. Made of heavy galvanized 1.90-inch outside diameter pipe, weighing 2.28 pounds per lineal foot.

   b. Welded or assembled with corner fittings.

2. Corner fittings, ball and socket hinges, catch stops, and center rest to be heavy galvanized malleable iron.

3. Hinges as required.

4. Provide diagonal cross-bracing.

J. Gate Posts

Posts shall be hot dipped galvanized pipe 2.875-inch outside diameter weighing 4.64 pounds per lineal foot.

K. Framework Material

All posts, rails, and braces to be heavy galvanized.

L. Lock Assembly and Gate Stop

1. Provide for each gate one double-hasp drive gate drop rod lock assembly set in concrete and one gate stop set in concrete.

2. All lock assemblies and gate stops shall be fabricated from heavy galvanized malleable iron.

3. Provide one vandal-proof keyed lock and three keys for each gate assembly.

M. Knox-Box® Bracket

Provide heavy duty galvanized bracket and brace bands for mounting Knox-Box® to gate post.

N. Vertical Privacy Slats

Vertical privacy slats (inserts) shall be extruded high density polyethylene (HDPE), bottom locking design. Color to be midnight black.

PART 3 EXECUTION

3.1 INSTALLATION

A. All materials and workmanship shall be first class in all respects and shall be done in a neat and workmanlike manner.

B. Installation shall be conducted in accordance with the requirements of the Chain Link Fence Manufacturers Institute and these Drawings & Specifications.

C. All line, terminal, gate stops, gate drop, and gate posts shall be fixed with a minimum of 3-foot embedment in concrete poured into a 1-foot diameter hole and plumb upon curing of the concrete.

D. Line posts shall be spaced not further than 10-foot on-center.

E. Gates shall have 3-inch clearance above ground surface and sized for the application shown.

F. Space ties at 14 inches on center.

END OF SECTION

SECTION 32 90 00 - PLANTING

PART 1 GENERAL

1.1 SCOPE

A. This Section includes the planting and establishment of plant materials, complete, including furnishing, delivery, planting, and maintenance of all trees, shrubs, and ground covers.

B. Section Includes:

1. Topsoil.
2. Imported topsoil.
3. Soil conditioners.
4. Fertilizer.
5. Mulch.
6. Anti-desiccant.
7. Fungi.
8. Tree staking and guying.
9. Standpipes.
10. Plant materials.
11. Plant guards.
12. Guarantee, maintenance, and warranty.

1.2 RELATED SECTIONS

A. Section 31 05 13, Soils for Earthwork.
B. Section 32 91 21, Finish Grading and Seeding.

1.3 SUBMITTALS

A. The following submittals are required as part of this work:

1. Proof of procurement and contract for delivery of plant material.

2. Schedule for delivery of plant material for inspection prior to planting.

3. Sources of plant materials, and identification tags visible for each plant.

4. Color-coded tagging system for all plant material species. (Flag all plant materials prior to installation.)

B. Plant Establishment and Maintenance Plan: Provide a proposed method and schedule for establishing and maintaining plant material and seeded areas for the duration of

the one-year guarantee and maintenance period, or through one growing season. The plan shall provide for the following:

1. During dry weather and generally between the months of May through October, water newly planted trees and shrubs adequately to maintain a healthy growing condition. Maintain an average of 1 inch of water per week during the one-year period. Increase watering when weather temperatures are above 90 degrees for more than 3 consecutive days. Program the irrigation system to provide 1 inch of water every 18 days during the dry months of the second year.

2. Water sufficiently to maintain soil moisture depth between 6"-8" of the finish grade.

3. Watering operations shall not cause erosion or surface runoff onto paved areas.

PART 2 MATERIALS

2.1 TOPSOIL

A. See Section 32 91 21, Finish Grading and Seeding.

2.2 IMPORTED TOPSOIL

A. See Section 32 91 21, Finish Grading and Seeding. Provide imported topsoil if native topsoil is not available or rendered useless by unauthorized construction activity.

2.3 SOIL CONDITIONERS

A. Organic Material

1. Garden Compost: Commercially manufactured material, made from dead plant material such as grass clippings, weeds, green and dead dry leaves, garden and vegetable material, and ground branches of trees and shrubs. Furnish a product that is composted under controlled aerobic decomposition, with the internal temperature reaching 135 °F for 15 days, without exceeding 155 °F. Ensure that it contains a maximum of 10% bacteria and 10% fungus. Additional certification may be required in areas having a certification program.

B. Sand

Clean, coarse, ungraded sand, meeting the requirements of ASTM C 33 for fine aggregate.

2.4 FERTILIZER

A. Commercial Fertilizer: A complete plant food containing 22% nitrogen, 16% phosphorous, 8% soluble potash, and a minimum 2% sulfur, conforming to applicable State fertilizer laws. Fertilizer shall be uniform in composition, dry, free-flowing, and delivered in original, unopened containers bearing manufacturer's guaranteed analysis.

2.5 MULCH

A. Arbor Chips: Mulch that is chipped from cleared site vegetation. Ensure that chipped material is free of any noxious weeds or invasive vegetation. Additional material can be sourced from arborists.

B. Organic Mulch: use same material as specified for Garden Compost, see 2.3, A, 1 this Section.

C. Rock Mulch: ¼-inch to ¾-inch graded crushed rock

2.6 ANTI-DESICCANT

A transpiration retarding material to be used where any plant material is moved during the normal growing season. Anti-desiccant may be composed of an acrylic polymer or vinyl latex compound, Wiltpruf or approved equal.

2.7 FUNGI

Commercially produced ectomycorrhizal and endomycorrhizal fungi that improve plant root absorption of soil nutrients.

A. Furnish mycorrhizae inoculum in granular or concentrated powder form for areas to be seeded. The product shall have an OMRI Listed™ seal from the Organic Materials Review Institute.

B. The product shall contain a minimum of the following four (4) species of Endomycorrhizae fungi: *Glomus intraradices, G. mosseae, G. aggregatum,* and *G. etunicatum*. The product shall contain a minimum of the following seven (7) species of Ectomycorrhizae fungi: *Rhizopogon villosullus, R. luteolus, R. amylopogon, R. fulvigleba, Pisolithus tinctorius, Scleroderma Cepa*, and *S. citrinum*.

C. The product shall be MycoApply® Endo/Endo Plus by Mycorrhizal Applications, Inc., or EcoLive™ Organics by Sunmark Environmental Services, LLC, or an approved equivalent.

2.8 TREE STAKING AND GUYING

A. Staking Materials

1. Vertical stakes shall be 2" x 2" x 8' (minimum) or 2" round X 8' sound new fir, or hemlock, free of knots and other defects.

2. Tree ties shall be placed on the tree to allow natural movement in the wind. Tree ties shall be placed to allow for two years growth of the trunk.

B. Guying Material

1. Anchors shall be 2" x 4" x 3' sound new heart cedar, fir or hemlock, free of knots or other defects.

2. Wires and tree ties shall be same as for staking with additional galvanized turnbuckle, centered in wire line with white industrial rubber hose, or manufactured product specific for this use.

2.9 PLANT MATERIALS

A. The Plant List is shown on the Drawings. Names of some species and varieties not included therein conform to names generally accepted in the native grown nursery trade. Information on sources for native plant material species can be obtained through the publication titled “Hortus Northwest.”

B. Nursery grown plant material shall be grown with a quality and habit of growth that is sound, healthy, vigorous, and free from insects, diseases, and injuries. Size shall be equal to or exceeding measurements indicated in the Plant List and measured before pruning with branches in normal position. Sizes and methods for handling shall be according to the American Standard for Nursery Stock recommended by the AAN.

C. Trees: Balled and burlapped trees shall be of height and caliper shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Single stem trees shall be provided except where special forms are shown or listed. Container grown trees are subject to AAN specifications for container grown stock.

D. Shrubs: Shrubs shall be of the height shown or listed and with not less than minimum number of canes required by ANSI Z60.1 for type and height of shrubs and vines required. Shrubs are balled and burlapped (B&B) or container grown.

E. Ground cover shall be plants established and well rooted in removable containers, and with not less than a minimum number of and length of runners required by ANSI Z60.1 for the pot size indicated on the drawings.

PART 3 EXECUTION

3.1 INSPECTIONS AND REPORTS

All plant materials shall be inspected prior to installation. Notify the ENGINEER 10 days prior to delivery date for inspection at the site. Each individual species shall bear a tag indicating species and source. Material not inspected prior to planting will be rejected at the ENGINEER's sole discretion.

3.2 TIME OF PLANTING

Conduct planting operations under favorable weather conditions during seasons which are normal for such work, generally during the periods of April 1 to June 1, and from September 1 to November 1. Planting operations outside these time periods may be conducted with approval of the Landscape Architect.

3.3 EXAMINATION

A. Examine the site for conditions that might adversely affect execution, performance, quality of the Work, and survival of plantings.

B. Take field measurements of landscape areas to determine if differences exist between plans and actual ground dimensions. Notify ENGINEER prior to proceeding with Work.

C. Verify that grades and slopes of landscaped areas insure positive drainage and that they are acceptable to ENGINEER prior to commencing Work.

3.4 DELIVERY

Supply plants designated B&B (balled and burlapped) in the Plant List with firm, natural balls of earth, or diameter and depth sufficient to encompass the fibrous and feeding root system necessary for vital plant growth. Rootball shall be firmly wrapped with burlap and bound with twine, cord or wire mesh. Manufactured rootballs or rootballs less than the diameter indicated for the caliper or size of plant material (American Standard for Nursery Stock) will be rejected.

Furnish plants designated CG or "gallon" (container grown) in the Plant List with self-established root systems sufficient to hold earth together after removal from the container but not root-bound, in a container of specified size.

3.5 PROTECTION DURING DELIVERY

A. Small Plant Material

1. If plants are not in a dormant state, spray with anti-desiccant to cover foliage as recommended by manufacturer. During shipment, protect plants with a tarpaulin or other covering to prevent excessive drying from sun and wind.

2. Cover balls of B&B plants and containers of CG plants which cannot be planted immediately upon delivery with moist mulch to protect from drying.

B. Trees

Spray trees with anti-desiccant immediately prior to digging. Protect the top of the tree by wrapping with burlap. Pad all parts of the tree to be cabled or roped. Keep soil balls and exposed roots moist during all digging and transporting operations.

Transport trees during favorable weather conditions. Trees damaged by exposure during transport will be rejected at the site. Damaged trees, as a result of improper or haphazard moving or planting techniques, will be rejected. Right of rejection shall be at the sole discretion of the ENGINEER.

3.6 LOCATION OF PLANTS

A. Locate new planting where shown on the Drawings except where obstructions below ground are encountered or where changes have been made in the construction. Review necessary adjustments with the ENGINEER and begin planting only after approval from the ENGINEER.

B. All plant material species to be flagged prior to planting, (see Part 1, paragraph 1.03, item 4.)

C. Plant trees in locations shown. Plant shrubs and ground cover plants in random patterns within designated areas with the quantities indicated in the plant list.

3.7 PLANTING PROCEDURES

A. Planting Area Preparation - All planting areas are to be Weed Free before planting or seeding operations begin. Prepare planting areas according to the following methods, or as otherwise specified:

1. Method "A" (Cultivated Planting Areas, Non-lawn) - Cultivate plant beds to a depth of 2 inches. Thoroughly mix 2 inches of soil conditioners into the top 12 inches of plant beds. In addition, add soil amendments, soil bio-amendments and fertilizers, as shown or specified, according to the soil amendment and soil bio-amendment reports recommendations, into the top 12 inches of topsoil.

Finish grades by raking to a grade tolerance of plus or minus 1 inch, with a smooth and firm condition, and an even grade that is free of undulations or low areas that could create standing water. Match existing grades at the perimeter. Finish to the proposed grades shown or specified.

On slopes that determines too steep to cultivate, plants may be planted in individual planting holes prepared using method "B".

2. Method "B" (Non-Cultivated Planting Areas) - Spray existing weeds and non-desirable vegetation with herbicide to kill all top growth and roots in areas not requiring cultivation. Use herbicides that have limited residual toxicity to permit safe planting as required under the Contract. Do not spray or otherwise harm plants to be saved. After inspection and approval, remove the dead top growth of plant material within 2 inches of the surface and dispose of. Replace plants to be saved that are damaged by herbicide application at no additional cost.

   Add any soil conditioners, soil amendments, soil bio-amendments or fertilizers with the backfill at each plant pit or to the seeding operation.

   Finish wetland mitigation planting areas to specified finish elevations, blending to existing ground smoothly, as required and directed. Except for projects that are less than one year in duration and unless otherwise approved, review the seasonal hydrology of the area to be planted for one full winter season (November 15 to February 28) prior to planting any wetland plants. Adjust plant types and planting locations as required or directed, based on the review of site hydrology.

   When planting seedling plants, completely scalp vegetation from a 12 inch diameter area around each planting hole. Clear all debris such as wood and rocks from the planting spots, provided debris is not deeper than 12 inches. When debris is deeper, move the planting location. Use herbicides around. seedlings only upon written approval of the Agency.

3. Method "C" (Sod Lawn and Seeded Lawn Areas) - Cultivate existing ground to a depth of 6 inches, achieving a loose and friable condition suitable for fine grading. Remove all vegetation, rocks larger than 2 inch diameter, clods, roots, sticks, debris, and other matter detrimental to the growth of sod.

   Uniformly spread soil conditioners, soil amendments, soil bio-amendments, and fertilizer evenly over the area and thoroughly rototill into the soil to a depth of 4 inches. Apply at rates recommended by soil testing, or as follows:

   Material Rate (per 100 square yards)

   Soil conditioner 1/2 cubic yard

Fertilizer 10 pounds

Lime (Western Oregon Only) 40 pounds

Fine-grade and roll planting areas with a water-filled roller to provide a fine-textured, smooth, firm surface, free of undulations, irregularities or low areas that could create standing water. Grade areas receiving sod to within 1/2 inch of the designed grades, and 1 inch below adjacent walks, curbs and pavement. Since sod thickness varies, adjust initial grades so the final sod soil level is slightly below adjacent hard surface grades. Ensure that final sod grade does not create a pedestrian tripping hazard.

Provide sod mixture information and a quality compliance certificate from the sod grower, certifying sod compliance with mixture requirements, according to 32 90 - Submittals.

Prior to completion of any sodding and seeding, re-grade ruts, footprints, washouts, or any other irregularities, and re-seed or re-sod repaired areas as originally specified.

4. Method "D" (Rough Areas Seeded for Revegetation or Erosion Control) - Remove any matter detrimental or toxic to the growth of plants, including weeds, clods, rocks, or debris. On slopes 1V:3H or flatter, remove all debris larger than 2 inches in any dimension. On cut slopes 1V:1.5H or flatter, roughen the surface with furrows parallel with slope contours and loosen the soil to a depth between 3 inches and 6 inches.

5. Method "E" (Temporary Seeding Areas) - If grading is required or directed, make equipment passes at right angles to the slope to form seed-holding tracks in the soil.

B. Plant Pits: Excavate circular pits with vertical sides for all plants as shown in the details. Scarify sides of plant pits. Dispose of excavated subsoil. The diameter of the pits shall be a minimum of 2.5 times the diameter of the rootball. Compact planting soil mix at the bottom of plant pit.

C. Setting Small Plants

Remove the top 2/3 of burlap and all twine or cord from the top and sides of balled and burlapped plant material. Cut containers or water and lift plant material out of containers. Set base of all plants 2 inches above finish grade and backfill with planting soil mix and water to fill voids. When hole is 2/3 filled place planting tablets evenly around ball, (see below.) Form a shallow saucer around plant at the edge of the pit.

D. Setting Evergreen Trees

1. Prepare pits to receive trees prior to digging trees in situ. Breakup side surfaces of tree pits with a pick or spade and scarify the bottom of pit to ensure that planting soil mix interfaces with native soil.

2. Lower tree into hole and stabilize in three locations before watering and backfilling with planting soil mix. All trees shall be properly aligned to be vertical after lowering rootball into hole. Take care when moving soil ball to avoid cracking and damaging roots.

3. Use hand spades and work soil into the hole, watering to ensure all air pockets are eliminated. Tamp backfill after the tree pit is 1/2 full to stabilize the lower half of the rootball.

4. Do not plant trees deeper than the level at which they originally grew. Do not plant in frozen ground or in freezing weather. All trees shall be planted in an upright, vertical position. Lopsided trees will be rejected.

E. Install tree staking and guying as shown in the details. Submit alternative staking and guying products for review prior to installation.

F. Mulching:

1. Mulch all tree pits and shrub layer areas with a 4-inch layer of arbor chip mulch within 2 days of planting. Mulch to entirely cover area around saucer of trees as specified on planting details.

2. Where rock mulch is shown on the Drawings, place a 4-to-6-inch depth and a 1 to 2 inch depth in planting areas. Rake to a smooth finish grade.

3.8 GUARANTEE

A. Guarantee all trees, shrubs, and seeded areas for a minimum of 1 year from substantial completion to be alive and in vigorous growing condition at the end of the guarantee period or through one growing season.

B. Plant Establishment and Field Reports: Visit the site as necessary, minimum twice a month between March to October and once a month between November to February, to control weeds, monitor the irrigation system, and inventory plant health. Provide a field report of activities complete every 3 months minimum documenting weed control activities, plants identified to be replaced, and replacement plantings complete. Payment will be made upon acceptance of field report in the following amounts:

1. Substantial Completion: 50% contract amount

2. Field Report 1: 12.5% contract amount. Must include completion of all punchlist items from substantial completion

3. Field Report 2: 12.5% contract amount.

4. Field Report 3: 12.5% contract amount.

5. Field Report 4 (Final): 12.5% contract amount. Must include 100% plants in vigorous growing condition, Irrigation Record drawing with programming/ operations instructions.

C. Perform plant replacements and reseeding operations at the first opportunity during a season favorable for planting as defined herein and in Section 32 91 21, Finish Grading and Seeding.

D. Plant Materials:

1. Remove and replace any unsatisfactory plants and replace with plants of the same kind, quality and size as specified in the Plant List.

2. Furnish and plant replacements as specified herein.

3. Replacements shall be at the Contractor's sole expense.

E. Seeded Areas:

1. Repair any damage to seeded areas by filling with topsoil, fertilizing, and seeding as specified. Reseed as specified under Section 32 91 21, Finish Grading and Seeding.

2. Reseeding shall be at the Contractor's sole expense.

3.9 MAINTENANCE

A. The Contractor is responsible for watering all plant material and seeded areas for Three years. Watering may be accomplished by installation of a temporary irrigation system.

1. Note water service provided for Contractor's use in developing a temporary irrigation system.

B. Perform the following maintenance operations during the one-year guarantee period:

1. Water as often as required to meet the requirements of the watering contract as stated above.

2. Remove all noxious weeds from plant beds and saucers by hand.

3. Mulch to maintain 4-inch arbor chip mulch depth.

4. Reset plants to finish grade and restoration of plant saucers, as necessary

5. Repair damaged or washed out erosion control seeding.

C. Report any problems that may be a hindrance to completing and fulfilling the conditions of the plant guarantee within 7 days to the Owner.

3.10 INSPECTIONS

A. Start of the Maintenance and Guarantee Period:

1. Notify the Engineer two weeks in advance of anticipated substantial completion of planting and seeding operations.

2. Observations will be performed prior to the start of the formal guarantee and maintenance period.

B. Quarterly Inspections:

1. The Owner will make quarterly inspections of the site for compliance with the maintenance requirements.

2. Unsatisfactory conditions will be noted and forwarded in writing to the Contractor for correction. Respond and/or provide remedy for unsatisfactory conditions within two weeks of Owner notification.

C. Final Acceptance:

1. Notify the Owner within 15 days of the date for final inspection.

2. Before final acceptance, the terms of the plant/seeding guarantee must be met.

3. If the Contractor is negligent in performing ongoing watering, maintenance and plant replacement during the guarantee period and only replaces dead and unacceptable plants at the end of the one-year period, the duration of the guarantee and maintenance periods may be extended in order that the Contractor may fulfill obligations to establish plant material through a growing season, as required under the guarantee at no additional cost to the Owner.

END OF SECTION

SECTION 32 91 21 - FINISH GRADING AND SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil Preparation
2. Weed control
3. Fertilizing
4. Seeding
5. Mulching
6. Hydroseeding
7. Hydromulching
8. Erosion Control Blanket
9. Maintenance and Establishment Period

B. Related Sections:

1. Section 31 22 13 - Rough Grading
2. Section 31 23 17 - Trenching
3. Section 32 90 00 - Planting

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Grassed Areas:

1. Basis of Measurement: By lump sum.

2. Basis of Payment: Includes seeding, mulching, watering, weeds control and maintenance to specified guarantee period including mowing.

1.3 REFERENCES

A. ASTM International (ASTM):

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.
2. 7 USC 1551-1611 - Federal Seed Act.

1.4 DEFINITIONS

A. Certified Seed: A grass or legume seed named variety that has been reviewed and accepted into the State Certified Seed program. Currently certified seed is individually sold in bags with a Certification Tag.

B. Pure Live Seed (PLS): Is a measure used to describe the percentage of a quantity of seed that will germinate. PLS is obtained by multiplying the purity percentage by the percentage of total viable seed, then dividing by 100.

C. Establishment Period: A period when planting work has been performed and initially accepted, and there is a contract requirement to care for the planted areas in some way until the period ends.

D. Sensitive Areas: Defined areas such as wetlands, natural water and riparian resources, special environmental zones, or where certain activities are restricted such as the use of chemicals.

E. Weeds: Vegetative species other than specified species to be established in given area.

F. Invasive Plants: Any species that appears on the State of Oregon or City of Gresham's standard current noxious weed list, plus known problem species including phalaris arundinacea, mentha pulegium, holcus lanatus, anthoxanthum odoratum odoratum. The last crop plants (if listed as non-native on United States Department of Agriculture (USDA) Plants Database) are considered invasive if it comprises more than 15 percent in any newly established vegetation.

G. Weed Control: Removal and prevent regrowth of specified weeds, weed parts, and weed seeds from area within the project limit.

1.5 SUBMITTALS

A. Product Data: Submit data for seed mix, mulch, tackifier, erosion control blanket, soil amendment materials, pesticides, herbicides, and other accessories. The product should meet or exceeds all product requirements specified herein.

B. Grass Seeds Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1. Certification of seed analysis, germination rate, and inoculation. Include the year of production and date of packaging. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing within 12 months of delivery date. Also include:

a. Name and address of laboratory

b. Date of test

c. Lot number for each seed certified

d. Test Results: Name, percentages of purity and of germination, and weed content for each seed mix.

C. Operation and Maintenance Data: Include maintenance instructions and weed control.

1.6 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Pesticide shall not be used in this project.

1.7 QUALIFICATIONS

A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum 3 years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 2 years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

C. Deliver tackifier sealed containers showing weight, chemical analysis, and name of manufacturer.

1.9 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement for 12 months from Date of Substantial Completion. Grass shall be well established and exhibits vigorous growing condition.

PART 2 PRODUCTS

2.1 SEED MIXTURE

A. Suppliers:

1. Sunmark Seeds, Portland, OR
2. Pro-Time Lawn Seed, Portland, OR
3. NaturesSeed.com
4. Approved equal

B. Seed Mixes: The following are the functional categories of seed mixes that may be included on projects (a category may have multiple functions on a project site):

1. Temporary Seeding - To provide short-term erosion control of disturbed soils and slopes that are not at finished grade and which will be exposed for 2 months or longer before being disturbed again, until permanent seeding is performed, or all potential for erosion is removed.

2. Permanent Seeding - The final seeding or only seeding performed for erosion control.

3. Lawn Seeding - Seeding for areas where finished turf appearance is desired.

4. Wildflower Seeding - Seeding to develop growth of wildflowers. The seed mix will typically contain grass or other plant seed to provide erosion control.

5. Plant Seeding - Seeding which typically includes more than just grass species, such as seeds of woody or herbaceous plants.

6. Water Quality Seeding - For use in water quality facilities such as swales or settling basins.

7. Wetland Seeding - To vegetate existing or constructed wetlands.

8. Native Plant Seeding - Seeding to restore native vegetation.

2.2 ACCESSORIES

A. Straw Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

B. Wood and Bark Mulching Material: Chipped wood and bark, sawdust, and ground wood mulch should be free of growth or germination inhibiting ingredients.

C. Compost: Commercially manufactured fine and medium compost materials.

D. Tackifier: Commercial tackifier containing no agent toxic to plant life and exhibits no growth or germination inhibiting factors at one of the following forms:

1. Liquid Stabilizer Emulsion - Tackifier with a base material of liquid containing not less than 55 percent total solids by weight. It should allow exchange of air and moisture to the seeds and have an effective life of 1 year or more.

2. Dry Powder Tackifier - Tackifier base consisting of one or more active hydrocolloids from natural plant sources, which hydrates in water and blends with other slurry materials, and upon application tacks the slurry particles to the Soil surface.

E. Fertilizer: Commercial grade; recommended for grass to eliminate deficiencies of topsoil and suitable for application with equipment designed for that purpose.

1. Deliver fertilizers in separate or mixture containers that have the percentage of total nitrogen, available phosphoric acid, and water-soluble potash (NPK) in the amounts specified. Label each container with a quality compliance certificate.

2. Application rate shall be determined by the soil conditions, as indicated in analysis to determine the proportions of Nitrogen percent, phosphoric acid percent, soluble potash percent.

F. Lime: ASTM C602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.

G. Water: Clean, fresh, and free of substances or matter capable of inhibiting vigorous growth of grass.

H. Erosion Control Blanket shall be open, flexible, and dimensionally stable network of fully-biodegradable, bonded, interlocking fibers. The blanket shall have a functional longevity of up to 12 months. Blanket fibers shall be turf green color or natural wood/straw color.

I. Pesticides/Herbicide: Submit proposed pesticides and receive approval before using. Submit a copy of the manufacturer's federal registered label and, if requested, a Material Safety Data Sheet. The Agency reserves the right to restrict chemicals from being used on sensitive areas.

1. Pesticide registered and approved by the Environmental Protection Agency (EPA), acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application.

2. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

3. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the erosion control layer.

4. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.3 SOURCE QUALITY CONTROL

A. Analyze soil to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

B. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of soil testing.

C. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Planting Season: Plant seeds when growing conditions are conducive to seed germination and quick but thorough establishment of seedlings.

1. Depending on latitude and elevation in the Pacific Northwest, these conditions occur either in mid-August through early October or mid-April to late May.

2. Avoid planting seed during the heat of summer or in late fall to avoid freezes that kill sprouting grass seeds.

C. Weed Control Coordinator - Submit certification at the preconstruction conference that the weed control coordinator meets the following minimum requirements:

1. Demonstrates ability to identify noxious and other weed species commonly seen in site location for at least 1 year conducting weed surveys.

2. Has successful weed control experience, with similar duties to those stated under typical duties below, on at least three construction or vegetation management projects. Certification of Pesticide Consultant License is preferred.

3. The weed control coordinator duties include:

a. Identify Specified Weeds.
b. Prepare and update the Weed Control Program.
c. Coordinate Contractor's weed removal Work and records.
d. Ensures the removed weeds are disposed of at an approved off-site facility.

D. Pesticide Applicator - Submit certification before application of pesticide Work begins, that when chemical weed control is used, that each applicator possesses a Commercial Pesticide Applicator's License held in the individual's name. Submit a certification each time a new applicator begins application Work on the Project.

E. Conduct soil analysis to determine soil fertility. The soil test should at least analyze the current nitrogen, phosphorus, potassium, and PH rates in the soil. Accordingly, the soil test result would suggest the proper soil amendment application including the rates of fertilizers and lime. Obtain the Engineer approval before applying soil amendment.

F. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

2. Uniformly moisten excessively dry soil that is not workable, and which is too dusty.

3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3.2 SOIL PREPARATION

A. Prepare area for seeding while generally considering the following:

1. Remove any matter detrimental or toxic to the growth of plants, including weeds, clods, rocks, or debris.

2. Application rates of fertilizer or lime shall be based on soil testing results.

3. Prepare a tilled, fine, but firm seedbed.

4. The soil shall have a pH range of 5.5 to 8.0.

B. Refer to Section 32 90 00 - Planting Procedures, for area preparation for the following kind of seeding:

1. Temporary Seeding - Method E
2. Permanent Seeding - Method D
3. Water Quality Seeding - Method B
4. Wetland Seeding - Method B
5. Lawn Seeding - Method C

3.3 WEED CONTROL

A. Do not harm or disturb any vegetation that was planted as proposed on the planting plans. Do not compact soil with heavy equipment.

B. Inspect the Project for new growth of specified weeds at least monthly during the plants growing season and apply weed control measures as appropriate.

1. Inspect the area at least every 30 days after growing season has begun or as directed for continuing control of all vegetation considered as weeds.

2. Provide schedule of weed control measures.

3. Request to use wheeled or tracked construction equipment in sensitive areas.

C. Remove and control weeds according to the following:

1. Verify the weed control methods before proceeding with weed control activities.

2. Remove all specified weeds and ensure that weed seeds or reproducing plant parts such as vines, runners, or rhizomes do not remain or become disbursed during control activities.

3. Place weeds and related materials in an approved container and transport to an approved offsite disposal facility according to applicable laws and regulations.

4. Keep the site weed free including weeds not initially documented.

D. Weed Control at Sensitive Areas - as determined by The Engineer:

1. Use only hand or light mechanical weed control methods within 50 feet of sensitive areas.

2. Hand methods include the use of hand tools. Light mechanical methods include the use of hand carried, motorized machinery.

E. Weed Control Corrective Work - If corrective work for areas identified as deficient by the Engineer, it should be completed within a 15 Calendar Day period,

3.4 SEEDING

A. Apply Seed mix A at rate of 1 pounds per 1000 square feet at erosion control area according to the plans.

B. Apply Seed mix B at rate of 1 pounds per 1000 square feet at stormwater facility area according to the plans.

3.5 HYDROSEEDING & HYDROMULCHING

A. Mix seeds, fertilizers, mulch, and tackifier with water in specific tank as follows:

1. Hydraulic Equipment should continuously mix and agitates the slurry providing a continuous, non-fluctuating delivery.

2. Provide a uniform distribution of the slurry.

3. Place seed, fertilizer, mulch, and tackifier in the hydroseeder tank no more than 30 minutes prior to application.

B. Hydroseeding operation: Perform hydroseeding according to the following:

1. One-Step Operation - Apply materials in one step only for the following situations:

a. When seeding in conjunction with erosion control matting. Apply seed, fertilizer, and tracer before installing matting.

b. When treating small areas that are 1,500 square feet or less and totaling no more than 0.5 acre, double the amount of seed to compensate for seed suspended above Soil by the mulch.

2. Two-Step Operation – for areas over 0.5 acre, use the two-step method for all hydroseeding/hydromulching operations:

a. Step 1 - Apply seed, fertilizer, and tracer.
b. Step 2 - Apply mulch and tackifier.

C. Seed -Thoroughly mix seeds when more than one kind is to be used.

D. Mulch - Apply at the following rates based on dry fiber weight:

1. Slopes Flatter Than 1V:2H - Apply cellulose fiber that includes a tackifier at a rate of 2,000 pounds per acre.

2. Slopes 1V:2H or Steeper - Apply cellulose fiber that includes a tackifier at a rate of 3,000 pounds per acre.

E. Tackifier for Cellulose Fiber Applications – apply dry tackifier to water tank at the following rates unless the manufacture recommends a greater rate of application:

1. Slopes Flatter Than 1V:2H - 60 pounds per acre mixed with hydromulch fibers at the rate specified.

2. Slopes of 1V:2H or Steeper - 100 pounds per acre mixed with hydromulch fibers at the rate specified.

3.6 MECHANICAL SEEDING

A. Seeding, fertilizing, and covering: The following may be used to stabilize small disturbed areas that are 1,500 square feet or less and totaling no more than 0.5 acre:

1. Seeds and fertilizer - Seed the disturbed area with the seed mix at the specified rate by mechanical spreader.

2. Cover - Cover seeded areas with one of the following:

a. Straw mulch at a rate of 100 pounds per 1,000 square feet. Spread the mulch uniformly approximately 2 inches deep, in loose condition, which requires roughly 2-1/2 tons per acre of dry mulch. Do not use straw mulch on slopes of 1V:1.5H or steeper.

b. Bark mulch spread uniformly at an approximate depth of 1/2-inch. Use well-decomposed mulch for seed mulching. Do not use bark mulch on slopes of 1V:1.5H or steeper.

c. Suitable open-weave, biodegradable erosion control matting installed according to manufacturer's instructions.

3.7 SEEDING OVER MULCHED AREAS

A. If an area has been previously mulched for erosion control or temporary seed and mulch is present on the soil surface, double the pound rate for each seed type used. Apply seed and fertilizer hydraulically or mechanically and add a green dye to the mixture to visibly aid uniform application. Upon approval, fertilizer and seed may only be applied after mulching if one of the following conditions apply:

1. Mulch is punched into the soil by mechanized means. Avoid heavy equipment that may compact the soil. Roll seeded area with roller not exceeding 112 pounds/linear foot.

2. Mulch that is held down with netting or like material

3. Mulch is removed prior to seeding.

3.8 WORK QUALITY

A. After application, apply water with fine spray immediately after each area has been hydroseeded Apply water with fine spray immediately after each area has been mulched.

B. Drift - Prevent drift and displacement of seed and fertilizer regardless of equipment and methods used.

C. Displacement - Prevent seed, fertilizer, and mulch from falling or drifting onto other areas where grass is detrimental. Remove material that falls on plants, roadways, gravel shoulders, structures, and other surfaces where material is not specified.

D. Damage - Prevent damage to prepared areas and to completed fertilizer, seed, and mulch work. Replace all material that becomes displaced before acceptance of the work.

3.9 MAINTENANCE

A. Control growth of weeds. Remedy damage resulting from improper use of herbicides.

B. Weed Control - Remove specified weeds prior to plants going to seed and keep weed control and seeded areas "Weed Free" throughout the Establishment Period.

C. Immediately reseed areas showing bare spots.

D. Repair washouts or gullies.

E. Protect seeded areas with warning signs during maintenance period.

F. Ensure that each seeded area has a uniform, healthy and weed-free stand of grass or other seeded plants growing at the end of the Establishment Period. The minimum living plant coverage standards for acceptance of seeding in a planted area are as follows:

1. Temporary Seeding:

    a. West of the Cascades - 70 percent coverage of ground surface.
    b. East of the Cascades - 30 percent coverage of ground surface.

2. Permanent Seeding:

    a. West of the Cascades - 90 percent coverage of ground surface.
    b. East of the Cascades - 30 percent coverage of ground surface.

3. Wetland Seeding - 70 percent coverage of ground surface.

4. Water Quality Seeding - 100 percent of ground surface.

G. Protection - Protect seeded areas from trespass and other hazards of damage. Use protective fences and signs at no additional cost to the Agency. Obtain approval of protective methods used.

H. Fertilizing and Watering - Apply fertilizer according to grass and soil requirements. Apply water according to good horticultural practice under the prevailing conditions,

as required to promote a healthy stand of plants. Obtain water at no additional cost to the Agency.

I. Mowing – If mowing is required, do the first mowing of grass when soil is firm enough to prevent rutting and grass is about 3 inches tall. After mowing, leave grass that is approximately 2 inches tall. At each subsequent mowing, leave about 1-1/2 inches of growth. After the second mowing, grass clippings may be left in place upon written approval.

J. Repair and Restore - Repair and restore soil grades and re-seed damaged, settled, or unproductive areas to the specified conditions of this Section at no additional cost to the Agency.

K. Finishing and Cleaning Up Cleanup - Remove weeds, trash, debris, stones, and other extraneous matter from seeded areas as directed and dispose of.

END OF SECTION

SECTION 33 01 30.13 - SEWER AND MANHOLE TESTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes methods for testing of gravity sewer piping, pressure sewer piping, manholes and wet wells.

B. Section includes:

1. Testing of Gravity Sewer Piping:

    a. Low pressure air testing

2. Testing of pressure piping

3. Deflection testing of plastic sewer piping

4. Testing of Manholes:

    a. Vacuum testing
    b. Exfiltration testing

5. Testing of Wet Wells

    a. Exfiltration testing

1.2 RELATED SECTIONS

A. Section 33 05 13 – Manholes and Wet Wells
B. Section 33 13 00 - Testing and Disinfection of Utility Piping
C. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

B. American Water Works Association (AWWA):

1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances

2. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit following items prior to start of testing:

1. Testing procedures
2. List of test equipment
3. Testing sequence schedule
4. Provisions for disposal of flushing and test water
5. Certification of test gage calibration
6. Deflection mandrel drawings and calculations

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.1 VACUUM TESTING

A. Equipment:

1. Vacuum pump

2. Vacuum line

3. Vacuum Tester Base:

a. Compression band seal
b. Outlet port

4. Shutoff valve

5. Stopwatch

6. Plugs

7. Vacuum Gage: Calibrated to 0.1-inch hectogram (Hg) (0.34 kilopascal (kPa)).

2.2 EXFILTRATION TESTING

A. Equipment:

1. Plugs

2. Pump
3. Measuring device

2.3 AIR TESTING

A. Equipment:

1. Air compressor
2. Air supply line
3. Shutoff valves
4. Pressure regulator
5. Pressure relief valve
6. Stopwatch
7. Plugs
8. Pressure Gage: Calibrated to 0.1 pounds per square inch (psi)

2.4 HYDROSTATIC TESTING

A. Equipment:

1. Hydro pump
2. Pressure hose
3. Water meter
4. Test connections
5. Pressure relief valve
6. Pressure Gage: Calibrated to 0.1 psi

2.5 DEFLECTION TESTING

A. Equipment:

1. "Go, no go" mandrels
2. Pull/retrieval ropes

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify manholes and piping are ready for testing.
B. Verify trenches are backfilled.
C. Verify pressure piping thrust restraint system is installed, as may be required.

3.2 PREPARATION

A. Obstructions:

1. After backfilling and restoration of surfaces, gravity pipelines shall be inspected for obstructions and shall be cleaned.

2. Pipes less than 24 inches in diameter shall be cleaned using the sewer ball method.

3. Lines larger than 36 inches in diameter may be cleaned by flushing as long as they are first visually inspected to assure that no physical obstructions exist.

    a. Flushing shall be such that velocities are at least 2-1/2 feet per second.

B. Lamping:

1. Lamp gravity piping after flushing and cleaning of lines, checking manholes for unfinished work.

2. Perform lamping operation by shining light at one end of each pipe section between manholes.

3. Observe light at the other end.

4. Pipe not installed with uniform line and grade will be rejected.

5. Remove and reinstall rejected pipe sections.

6. Reclean and lamp until pipe section is installed to uniform line and grade.

C. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Testing of Gravity Sewer Piping:

1. Low Pressure Air Testing:

    a. Test each reach of gravity sewer piping between manholes.

    b. Introduce air pressure slowly to approximately 4 pound-force per square inch gauge (psig).

        1) Determine ground water elevation above spring line of piping.

        2) For every foot of ground water above spring line of piping, increase starting air test pressure by approximately 0.4 psi.

3) Do not increase pressure above 10 psig.

c. Allow pressure to stabilize for at least 5 minutes.

d. Adjust pressure to 3-1/2 psig or to increased test pressure as determined above when ground water is present.

e. Testing:

1) Determine test duration for reach of sewer with single pipe size from following table; do not make allowance for laterals.

Table 33 01 30.13 -1
Air Testing Duration for Gravity Sewer Piping

NOMINAL PIPE SIZE, INCHES	MINIMUM TESTING TIME, MIN/100 FEET
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

2) Record drop in pressure during testing period.

3) If air pressure drops more than 1.0 psi during testing period, piping has failed.

4) If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.

5) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

B. Testing of Pressure Piping:

1. Test system according to AWWA C600 and the requirements of Section 33 13 00, Testing and Disinfection of Water Utility Piping.

C. Deflection Testing of Plastic Sewer Piping:

1. Perform vertical ring deflection testing on PVC and acrylonitrile butadiene styrene (ABS) sewer piping after backfilling has been in place for at least 30 days but not longer than 12 months.

2. Allowable maximum deflection for installed plastic sewer pipe is no greater than 5 percent of original vertical internal diameter.

3. Perform deflection testing using properly sized rigid ball or "go, no go" mandrel.

4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured; measure pipe diameter in compliance with ASTM D2122.

5. Perform testing without mechanical pulling devices.

6. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

D. Testing of Manholes:

1. Description:

a. Option of air testing or exfiltration testing.

b. If air testing, test whenever possible prior to backfilling in order to more easily locate leaks.

c. Repair both outside and inside of joint to ensure permanent seal.

d. Test manholes with manhole frame set in place.

2. Vacuum test according to ASTM C1244 and following:

a. Plug pipe openings; securely brace plugs and pipe.

b. Inflate compression band to create seal between vacuum base and structure.

c. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10-inch Hg.

d. Close valve.

e. Testing:

1) Determine manhole testing duration using following table:

MANHOLE DIAMETER (feet)	TEST PERIOD
4	60 seconds
5	75 seconds
6	90 seconds

2) Record vacuum drop during test period.

3) If vacuum drop is greater than 1-inch Hg during testing period, repair and retest manhole.

4) If vacuum drop of 1-inch Hg does not occur during test period, manhole is acceptable; discontinue testing.

5) If vacuum test fails to meet 1-inch Hg drop-in specified time after repair, repair and retest manhole.

3. Exfiltration Testing for Wet Well:

a. Plug pipes in wet well.

b. Remove water from wet well.

c. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole.

d. Determine ground water level outside manhole.

e. Fill structure with water to its rim at the start of the test.

f. Prior to testing, allow structure to soak from minimum of 4 hours to maximum of 72 hours.

g. After soak period, adjust water level to rim of structure.

h. Leakage in the structure shall not exceed 0.2 gallons per foot of head above the highest invert after a one-hour test period.

4. If unsatisfactory testing results are achieved, repair structure and retest until result meets criteria.

5. Repair visible leaks regardless of quantity of leakage.

END OF SECTION

SECTION 33 05 13 – MANHOLES AND WET WELLS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes cast-in-place and precast concrete manholes and covers for access to subsurface drainage piping or utilities.

B. Section Includes:

1. Cast-in-place concrete manholes with transition to cover frame, covers, anchorage, and accessories.

2. Modular precast concrete manhole with tongue-and-groove joints with precast transition to cover frame, covers, anchorage, and accessories.

3. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete Work
B. Section 03 21 00 - Reinforcing Steel
C. Section 31 05 13 - Soils for Earthwork
D. Section 31 05 16 - Aggregates for Earthwork
E. Section 31 23 16 - Excavation
F. Section 31 23 23 - Fill
G. Section 33 01 30.13 - Sewer and Manhole Testing
H. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M-198B – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

B. American Concrete Institute (ACI):

1. ACI 301 – Building Code Requirements for Structural Concrete
2. ACI 315 – Details and Detailing of Concrete Reinforcement
3. ACI 318 – Building Code Requirements for Structural Concrete

C. ASTM International (ASTM):

1. ASTM A48 - Standard Specification for Gray Iron Castings

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

4. ASTM C55 - Standard Specification for Concrete Building Brick

5. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)

6. ASTM C150 - Specifications for Portland Cement

7. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

8. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile

11. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

12. ASTM C913 - Standard Specification for Precast Concrete Stormwater and Wastewater Structures

13. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

14. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

D. Federal Specifications:

1. SS-S-00210 (210-A) – Specification for Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

E. US Army Corp of Engineers:

1. CRD-C 621 – Specifications for Non-Shrink Grout

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Pre-cast concrete manholes:

a. Design criteria and calculations.
b. Details of reinforcement.

2. Steps.

3. Cover and frame construction, features, configuration, dimensions and material specifications.

4. Rubber gaskets.

5. Grout and mortar.

C. Shop Drawings:

1. Indicate manhole by location.

2. Provide dimensions, elevations, joints, location, and type of lifting inserts.

3. Indicate connecting piping material, piping size, piping connection angles and offsets, and sizes of penetrations.

D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

C. Storage:

1. Store precast concrete manholes as to prevent damage to Owner's property or other public or private property.

2. Repair property damaged from materials storage.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA FOR MANHOLES

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: According to ASTM C913.

C. Design of Joints for Precast Components:

1. According to ASTM C913.
2. Lipped male/female joints.
3. Maximum Leakage: 0.025 gallons per hour per foot of joint at 3 feet of head.

D. Shaft Construction:

1. Reinforced concrete.
2. Concentric with eccentric cone top section
3. Sleeved to receive pipe connections.

E. Wall Thickness:

1. Minimum wall thickness shall be 5 inches.
2. Cones shall have the same wall thickness and reinforcement as riser sections.

F. Shape: Cylindrical.

G. Clear Inside Dimensions:

1. As indicated on Drawings.

2. Sections shall consist of circular sections in standard nominal inside diameters of 42, 48, 54, 60, 72, 84, 96, 108, 120, 132, or 144 inches.

H. Design Depth:

1. As indicated on Drawings.

I. Clear Cover Opening: As indicated on Drawings, minimum of 30 inches.

J. Pipe Entry: Furnish openings as required and as indicated on the Drawings.

K. Steps:

1. Rungs:

a. Material: Formed polypropylene with 1/2-inch diameter, Grade 60 reinforcing bar.

b. Comply with ASTM C478.

c. Reinforcing bar to comply with ASTM A615.

2. Formed integral with manhole sections.

3. Width: Minimum 12 inches.

4. Spacing: 12 inches on center vertically.

2.2 WET WELLS

A. Cast-in-Place Concrete Wet Wells:

1. Sections: Reinforced cast-in-place concrete as specified in Section 03 30 00 – Cast-in-Place Concrete Work.

2. Concrete forming in accordance with Section 03 30 00, Cast-in-Place Concrete Work .

2.3 MANHOLES

A. Precast Concrete Manholes:

1. Sections:

a. Description: Reinforced precast concrete according to ASTM C478.
b. Gaskets: According to ASTM C923.
c. Heights: Multiples of 6 inches.

2. Bases:

a. Base slab integral with sidewalls.
b. Monolithic construction, conforming to ASTM C478.

B. Cast-in-Place Concrete Manholes:

1. Sections: Reinforced cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete Work.

2. Concrete forming in accordance with Section 03 30 00, Cast-in-Place Concrete Work .

C. Joint Materials:

1. Mortar:

a. Conform to ASTM C387.

b. Admixtures

1) Allowable, not exceeding the following percentages of weight of cement:

a) Hydrated lime, 10 percent
b) Diatomaceous earth or other inert materials, 5 percent

c. Consistency: Shall be such that it will readily adhere to the precast concrete if using the standard tongue and groove type joint.

d. Mortar not used within 30 minutes of initial mixing shall be discarded and not be used.

2. Non-Shrink Grout:

a. Description: Non-metallic, cementitious, commercial grout exhibiting zero shrinkage per ASTM C827 and CRD-C-621.

b. Manufacturers:

1) Preco-Patch
2) Sika 212
3) Euco N-S
4) Five-Star
5) Approved equal

3. Grout shall not be amended with water after initial mixing.

4. Grout not used within 20 minutes of initial mixing shall be discarded and not be used.

5. Commercial Concrete Bonding Agent:

    a. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted.

    b. Bonding agent shall be compatible with the brand of grout used.

    c. Water shall not be used as a substitute for the commercial bonding agent.

D. Preformed mastic gaskets for manhole joints shall meet Federal Specifications SS-S-00210 (210-A), AASHTO M-198B and ASTM C990.

E. Reinforcement:

1. Formed steel wire.

2.4 FRAMES AND COVERS

A. Description:

1. Construction: ASTM A48, Class 30B cast iron.

2. Lid:

    a. Machined flat bearing surface.
    b. Removable.

3. Cover Design: Closed.

4. Live Load Rating: AASHTO H20 loading.

5. Cover: Molded with “S” cast in.

6. Coefficient of Friction on Outside Face: Minimum of 0.60.

2.5 RISER RINGS

A. Description:

1. Four inches to 6 inches Thick:

    a. Material: Precast concrete.
    b. Comply with ASTM C478.

2. Less than 4 inches Thick:

    a. Material: Cast iron.

b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

a. Wraps and Band Widths: Conform to ASTM C877, Type III.
b. Cone/Riser Ring Joint: Minimum 3 inches overlap.
c. Frame/Riser Ring Joint: 2 inches overlap.
d. Additional Bands: Overlap upper band by 2 inches.

2.6 ACCESS HATCHES FOR WET WELL

A. Provide access hatches as specified in section 05 50 00 Metal Fabrications.

2.7 MATERIALS

A. Bedding and Cover:

1. Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Backfill Around Structure: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Soil Backfill from Above Pipe to Finish Grade:

a. In existing or future roadways, right-of-way:

1) Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

b. In non-paved areas outside of footprint of existing or future structures, outside of right-of-way:

1) Soil Type S1, as specified in Section 31 05 13, Soils for Earthwork.
2) Subsoil: No rocks over 6 inches in diameter, frozen earth, or foreign matter.

2.8 FINISHES

A. Steel:

1. Galvanizing:

a. ASTM A123.
b. Hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify items provided by other Sections of Work are properly sized and located.
B. Verify built-in items are in proper location and ready for roughing into Work.
C. Verify correct size of manhole excavation.

3.2 PREPARATION

A. Design the method of placement for all precast items and add all reinforcing steel, embeds, bracing, and other items necessary for placement. All portions of embeds which remain embedded in the concrete shall be made of stainless steel.

B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

D. Do not install manholes where site conditions induce loads exceeding structural capacity of manhole components.

E. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage; remove and replace damaged units.

F. Subgrade

1. Subgrade shall be compacted to 95 percent of maximum density.

2. Compacted subgrade shall be covered with a minimum of 6 inches of aggregate base compacted to 95 percent of maximum density, extending a minimum of 6 inches beyond the outside limits of the manhole, unless otherwise indicated on Drawings.

3. Grade the aggregate base to a uniform, level surface which will fully support the structure and to an elevation that will ensure proper positioning of the top slab or lid.

3.3 INSTALLATION

A. Excavation and Backfill:

1. Excavate manholes as specified in Section 31 23 16, Excavation in location and to indicated depth.

2. Provide 12 inches of clearance around sidewalls of structure for construction operations.

3. When groundwater is encountered, prevent accumulation of water in excavations and place manholes in dry trench.

B. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation as approved by Engineer.

C. Base Pad:

1. Place base pad.
2. Trowel top surface level.

D. Backfill excavations for manholes as specified in Section 31 23 23, Fill.

E. Form and place manhole cylinder plumb and level and to correct dimensions and elevations.

F. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.

G. Set cover frames and covers level without tipping and to correct elevations.

H. Coordinate with other Sections of Work to provide correct size, shape, and location.

I. Precast Concrete Manholes:

1. Assembly:

a. Install precast structures in accordance with the manufacturer's recommendations unless otherwise required by the Contract Documents.

b. Verify installed manholes meet required alignment and grade.

c. Lift precast components at lifting points designated by manufacturer.

d. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.

e. Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified in Section 31 23 23, Fill or on other support system as indicated on Drawings.

f. Assemble multi-section structures by lowering each section into excavation; set level and firmly position base section before placing additional sections.

g. Place manhole sections plumb and level, trim to correct elevations, and anchor to base pad.

h. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.

i. Maintain alignment between sections by using guide devices affixed to lower section.

2. Joints:

a. Sealing materials may be installed onsite or at manufacturers plant.

b. All joints shall be sealed watertight by the use of rubber gaskets or other approved preformed sealant.

c. All joints shall then be filled with non-shrink grout on both the inside and outside surfaces to produce smooth interior and exterior surfaces.

3. Concrete Base Installation:

a. Bases shall be set at the proper grade to allow pipe openings to match the grades for connecting pipes.

b. Invert shall be constructed to a section identical with that of the sewer pipe.

c. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces.

d. Prevent sewage or water from contacting the new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

e. Manhole bases shall be set level so base gravel fully and uniformly supports them in true alignment with uniform bearing throughout full circumference.

f. Do not level the base sections by wedging gravel, or other material, under the edges.

g. Flexible connectors shall be installed in the base section to form a permanently watertight seal.

4. Manhole Riser Sections:

   a. Precast manhole components may be used to construct standard, drop and carry-through manholes. Manholes less than 4 feet in depth measured from the spring line of the pipe to the bottom of the lower riser ring shall be flat-top manholes.

   b. Install manhole riser sections at the location shown on the plans. All sanitary sewer and pollution control manholes joints shall be watertight and shall use rubber gaskets or a preformed sealant. All joints shall then be filled with non-shrink grout inside and out so as to produce smooth interior and exterior surfaces. All manhole penetrations shall be watertight. Complete manholes shall be rigid. Compact backfill in accordance with the provisions stated elsewhere in this document.

   c. All lift holes shall be thoroughly wetted, completely filled with mortar, and smoothed and pointed both inside and out to ensure watertightness.

   d. The shortest length of riser section to be incorporated into the manhole shall be installed immediately below the flat slab top or cone.

   e. Properly locate and plumb each manhole riser section.

   f. Install manhole extensions and top slabs in accordance with manufacturer's specifications and as shown on the plans. Lay section risers with the sides plumb and the tops level. Make joints and penetrations watertight.

   g. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.

5. Entrances/Exits:

   a. Cut pipe flush with interior of structure.

   b. Shape inverts through manhole as indicated on Drawings.

   c. All rigid non-reinforced pipe entering or leaving the manhole (new or existing manhole) shall be provided with flexible joints within 1-foot of the structure and shall be placed on compacted bedding.

   d. Ribbed HDPE pipe connections shall be grouted watertight with non-shrink grout.

e. PVC pipe shall be connected to manholes using an approved adapter specifically manufactured for the intended service.

1) Adapters shall be Fernco, Kor-N-Seal, or approved equal.

6. Grates, Frames, and Covers:

a. Manhole frames, grates, and covers shall be installed in such a manner as to prevent infiltration of surface or groundwater between the frame and the concrete of the manhole section. Use preformed rubber ring to form a watertight seal.

b. Manhole frames and covers shall be installed to grades shown on the drawings or as directed.

c. Adjustment of manhole castings shall be made using specified precast grade rings and approved rubber ring joints.

d. The maximum depth of adjustment below any manhole casting shall be 16 inches, and a minimum depth of adjustment shall be 4 inches.

J. Cast-in-Place Concrete Manholes:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.

2. Erect and brace forms against movement as specified in Section 03 30 00, Cast-In-Place Concrete Work.

3. Install reinforcing steel as indicated on Drawings and as specified in Section 03 30 00, Cast-In-Place Concrete Work.

4. Place and cure concrete as specified in Section 03 30 00, Cast-In-Place Concrete Work.

5. Frames and Covers:

a. Set frames using mortar and masonry.

b. Install radially laid concrete brick with 1/4-inch thick vertical joints at inside perimeter.

c. Lay concrete brick in full bed of mortar and completely fill joints.

d. If more than one course of concrete brick is required, stagger vertical joints.

e. Set frame and cover as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

A. Test concrete manhole and structure sections according to ASTM C497.

B. Perform manhole testing according to Section 33 01 30.13, Sewer and Manhole Testing.

C. Test cast-in-place concrete as specified in Section 03 30 00, Cast-In-Place Concrete Work.

D. Vertical Adjustment of Existing Manholes:

1. If required, adjust top elevation of existing manholes to finished grades as indicated on Drawings.

2. Reset existing frames, grates, and covers that were carefully removed and cleaned of mortar fragments to required elevation according to requirements specified for installation of castings.

3. When removal of existing concrete wall is required, remove concrete without damaging existing vertical reinforcing bars, clean concrete from vertical bars, and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 30 00, Cast-In-Place Concrete Work.

END OF SECTION

SECTION 33 05 17 - PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete valve vaults.
2. Precast concrete meter boxes.

1.2 RELATED SECTIONS

A. Section 05 50 00, Metal Fabrications
B. Section 31 05 16, Aggregates for Earthwork
C. Section 31 23 16, Excavation
D. Section 31 23 23, Fill.

1.3 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
6. ASTM C33 - Standard Specification for Concrete Aggregates.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

16. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests).

17. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 COORDINATION

A. Coordinate Work with utilities within construction area.

B. The drawings identify precast vaults and meter boxes by manufacturer and model number. This information is provided for dimensional information only. Provide precast items in accordance with the requirements of this Section.

1.5 PREINSTALLATION MEETINGS

A. Convene a minimum of 1-week prior to commencing Work of this Section.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on valve vaults and meter boxes.

C. Shop Drawings for Precast Concrete Valve Vaults:

1. Indicate plan, location, and inverts of connecting piping.
2. All interior and exterior dimensions.
3. Location and type of lifting inserts, connection embeds, and joints.
4. Details of reinforcement.
5. Covers or hatches.

6. Ladders and grating.

D. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and specified requirements.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.8 QUALITY ASSURANCE

A. Perform Work according to standards identified in Article 1.2 herein.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Transport and handle precast concrete units with equipment designed to protect units from damage.

C. Storage:

1. Store precast concrete valve vaults and meter boxes according to manufacturer instructions.

2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Performance and Design Criteria:

1. Watertight, Precast, Reinforced, Air-Entrained Concrete Structures:

a. Manufactured to conform to ASTM C913.

2. Loading:

a. Design to ASTM C890-A16 / AASHTO HS20 live loading and installation conditions.

b. Where vaults are below grade, a dead load of 125 pounds per cubic foot shall be added for the soil.

c. Lateral loads:

1) Static: 105 x Depth of fill per square foot (psf) triangular equivalent fluid pressure plus a surcharge of an additional 3 feet of soil depth in areas subject to vehicular traffic (assume traffic load in all areas, unless indicated otherwise by the Contract Documents).

2) Seismic acceleration: UBC Zone 3 requirements (I = 1.25) where I = importance factor, I = 1.25, but not less than 0.20 grams (g) acting on structure mass. Seismic loading need not be considered simultaneously with traffic surcharge.

3. Minimum 28-Day Compressive Strength: 3,000 pounds per square inch (psi).

4. Honeycombed or re-tempered concrete is not permitted.

5. No knockouts shall be cast into vault walls. All pipe penetrations shall be pre-formed or core-drilled at the required locations.

6. Accessories: Accessories such as ladders, floor grates at sumps, and other features shall be provided as shown on the Drawings.

7. Size: Vault dimensions shall be as required by the Drawings.

2.2 PRECAST CONCRETE VALVE VAULTS

A. Manufacturers:

1. Manufacturer shall be Oldcastle Precast, Inc, or approved equal.

B. Valve Vault Frames and Covers:

1. Cast Iron Castings:

a. ASTM A48, Class 30 or better.
b. Free of bubbles, sand, air holes, and other imperfections.

C. Access Steps:

1. Steel reinforced formed polypropylene:

a. ASTM C478
b. Reinforced rod: ASTM A615, Grade 60, 1/2-inch diameter

2. Aluminum: ASTM B221, Alloy 6061-T6

3. Width: Minimum 12 inches

4. Spacing: 12 inches on center vertically.

2.3 METER BOXES

A. As specified in the Plans.

2.4 ACCESS HATCHES AND LIDS

A. Unless noted otherwise elsewhere in the Contract Documents, vaults shall have concrete top slabs with access openings as shown on the Drawings.

B. Vault manufacturer shall provide the access hatches per the requirements of Section 05 50 00, Metal Fabrications.

C. Lids shall have lifting holes.

D. When leveling bolts are used to set the vault top sections, ensure the load from the top slab is transferred through grout to the vault walls so that the load is not carried by the leveling bolts.

2.5 MATERIALS

A. Portland Cement:

1. ASTM C150, Type II

B. Coarse Aggregates:

1. ASTM C33
2. Graded 1 inch to No. 4 sieve

C. Sand:

1. ASTM C33
2. Fineness Modulus: 2.35

D. Water:

1. Potable.

2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.

E. Air-Entraining Admixtures: ASTM C260

F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 40 minimum
2. Welded Wire Fabric: ASTM A185

G. Gaskets:

1. Rubber gaskets: ASTM C443

H. Joint Sealant:

1. ASTM C990

I. Bedding:

1. Aggregate Bedding Material: Fill Type A1 as specified in Section 31 05 16, Aggregates for Earthwork. Size as shown in the Drawings.

2.6 FABRICATION

A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

B. Vaults may be formed with separate top and bottom slabs.

C. Walls shall be cast so that all sides are continuous at corners and their full length with no block-outs or knockouts.

D. Horizontal joints may be provided so that walls can be placed in horizontal segments.

E. All horizontal joints shall be keyed to prevent offsets and shall be provided with a watertight gasket.

F. Finish:

1. Formed surfaces shall be smooth and uniform with no fins, bulges, or other irregularities.

2. Any void greater in width than 1/2-inch or deeper than 3/8-inch shall be repaired.

3. Unformed interior slab surfaces shall have a smooth steel trowel finish.

4. Unformed exterior slab surfaces shall have a light broom finish applied to a steel trowel finish.

2.7 MIXES

A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

A. Ream pipe ends and remove burrs.

B. Remove scale and dirt from components before assembly.

C. Establish invert elevations for each component in system.

D. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

A. Vaults/Meter and Bedding:

1. Excavate as specified in Section 31 23 16, Excavation for Work of this Section.

2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.

3. Place bedding material level in one continuous layer to a minimum compacted depth of 6 inches.

4. Compact bedding material to 95 percent maximum density.

5. Bases for precast concrete structures shall be set level so that bedding material fully and uniformly supports them in true alignment with uniform bearing throughout full perimeter. Do not level bases by wedging gravel under the edges.

6. Backfill around sides of vaults and meter boxes as required by the Drawings.

B. Connect piping.

3.4 FIELD QUALITY CONTROL

A. Request examination of subgrade by Engineer prior to placing aggregate base under precast materials.

B. Compaction Testing: In accordance with Field Quality Control requirements of Section 31 23 23, Fill.

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

D. Frequency of Compaction Tests: In accordance with Section 01 45 00, Quality Control.

END OF SECTION

SECTION 33 11 50 - EXISTING PIPE ABANDONMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the removal of existing buried piping and abandonment in place of existing buried piping.

B. Section includes:

1. Pipe removal.
2. In-place abandonment of pipe.

1.2 RELATED SECTIONS

A. Section 03 60 00, Grouting.
B. Section 31 23 16, Excavation.
C. Section 31 23 17, Trenching.
D. Section 31 23 19, Dewatering.
E. Section 31 23 23, Fill.
F. Section 31 23 24, Flowable Fill.

1.3 SUBMITTALS

A. Provide all submittals in accordance with Section 01 33 00, Submittal Procedures.

B. Piping Abandonment Plan:

1. Identify locations specified for pipe abandonment.

2. Provide method to be utilized to abandon the pipe, including whether the pipe will be left in place or removed in its entirety.

C. Non-Shrink Grout: Product data in accordance with Section 03 60 00, Grouting.

D. Controlled low-strength material (CLSM): Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the work described herein.

B. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of workmen, other persons, and property in the vicinity of the work and requirements of the General Provisions.

1.5 PROTECTION OF EXISTING WORK

A. Carefully examine the Contract Documents to determine the extent of the work of this Section.

B. Carefully coordinate the work of this Section with all other work and construction.

C. Take all necessary precautions to prevent damage to existing facilities or utilities which are to remain in place and be responsible for any damages to existing facilities or utilities, which are caused by the operations.

1.6 REPAIR OF DAMAGE

A. Work procedures shall provide for safe conduct of the work; careful removal and disposition of materials and equipment; protection of facilities, utilities and property which are to remain undisturbed; coordination with existing facilities and utilities to remain in service.

B. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired to acceptance of Engineer.

C. Damaged items shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

1.7 EXISTING CONDITIONS

A. If the pipe material contains any hazardous materials, such as asbestos, requiring special handling upon removal, it is the responsibility of the Contractor to remove and dispose of the material in accordance with all applicable federal, state, and local regulations.

PART 2 PRODUCTS

2.1 OWNERSHIP OF EXISTING MATERIALS

A. All materials, equipment, miscellaneous items and debris involved, occurring or resulting from pipe removal work shall become the property of the Contractor at the place of origin, unless otherwise specified in the Drawings or by the Engineer.

2.2 CONTROLLED LOW STRENGTH MATERIAL

A. As specified in Section 31 23 24, Flowable Fill.

PART 3 EXECUTION

3.1 PIPE REMOVAL

A. Where identified on the Drawings, remove and dispose of all pipe material and associated appurtenances.

1. All fire hydrants, air release valves service lines and appurtenances being abandoned shall be removed to 36 inches below finished grade.

2. Existing service line appurtenances, including valve and meter boxes, shall be removed to 36 inches below finished grade.

B. All exposed ends of pipes and fittings to remain in service shall be capped or plugged with an appropriate ductile iron blind flange, cap or plug and restrained.

1. A pipe shall be considered in service if it is possible to flood the pipe with water by opening valves in the water system.

C. All excavation and backfilling associated with pipe removal shall be performed in accordance with 31 23 17, Trenching.

3.2 IN-PLACE ABANDONMENT OF PIPING

A. Where identified on the Drawings, abandon pipe in place.

B. All exposed ends of pipes being abandoned in place shall be cut and plugged with a minimum of 2 feet of non-shrink grout.

C. Prior to placing grout, roughen interior pipe surface and apply epoxy bonding agent.

3.3 FILLING PIPE WITH CLSM

A. Where identified on the Plans, pipes greater than 12 inches in diameter to be abandoned-in-place shall be filled with CLSM.

B. CLSM shall be placed in a manner to ensure complete filling of the pipe, leaving no cavities or voids.

C. Install hot taps, saddles, fill lines, and appurtenances as necessary for pumping CLSM from the surface into the pipe being filled.

D. CLSM shall be pumped up grade from fill lines rigidly connected to the pipes being filled.

E. Placement of CLSM by free flowing (non-pumped) methods will not be acceptable.

F. Fill lines shall be located at elevations lower than the pipe being filled.

G. As the CLSM is being placed, use other fill lines as view ports to ensure complete filling of the pipes.

H. Relocate pumping equipment as necessary to complete filling of the pipes.

I. Excavate and cut access holes in the pipes as necessary to complete filling operations.

J. Perform pipe filling operations in a manner to eliminate all air pockets.

K. Submit volume calculations for CLSM placed in each filled segment of piping to verify that pipelines have been completely filled.

3.4 CLEANUP

A. During and upon completion of work of this Section, promptly remove all unused tools and equipment, surplus materials and debris.

B. Adjacent areas shall be returned to their existing condition prior to the start of work.

END OF SECTION

SECTION 33 12 13

WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes pipe materials, fittings, valves, meters and backflow preventers encountered with service connections 2 inches in diameter and smaller from the main to a water meter.

B. Section Includes:

1. Pipe and fittings for 2- inch diameter and smaller water service connections.
2. Corporation stop assemblies.
3. Curb stop assemblies.
4. Meter setting equipment.
5. Water meters.
6. Backflow preventers.
7. Sampling stations.
8. Underground pipe markers.
9. Precast concrete vaults.
10. Bedding and cover materials.

C. Related Requirements:

1. Section 31 05 13 - Soils for Earthwork
2. Section 31 05 16 - Aggregates for Earthwork
3. Section 31 23 17 - Trenching
4. Section 31 23 23 - Fill
5. Section 33 05 13 – Precast Manholes & Wet Wells
6. Section 33 05 17 - Precast Concrete Valve Vaults and Meter Boxes
7. Section 33 13 00 - Testing and Disinfecting of Utility Piping

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. American Society of Mechanical Engineers:

1. ASME B16.15 - Cast Bronze Threaded Fittings.

C. American Society of Sanitary Engineering:

1. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.

2. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.

D. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

4. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.

5. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

6. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

7. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

8. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

9. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

10. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:

1. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

2. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.

3. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.

4. AWWA C800 - Underground Service Line Valves and Fittings.

5. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.

6. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. National Sanitation Foundation International:

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventer, and accessories.

C. Shop Drawings: Indicate details showing meter boxes, vaults and accessories.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping mains, connections, thrust restraints, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Unless otherwise noted, all water works materials provided shall be new, of first class quality and shall be made by reputable manufacturers.

B. All material of like kind shall be provided from a single manufacturer unless otherwise approved by the Engineer.

C. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage and handling.

D. Where an item is to be used but does not have its quality specified herein, it shall be equal to that specified in the appropriate American Water Works Association (AWWA) Standard Specification.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store products and materials off ground and under protective coverings and away from walls.

C. Exercise care in handling precast concrete products to avoid chipping, cracking, and breakage.

PART 2 PRODUCTS

2.1 GENERAL

A. Service line material shall conform to the latest version of AWWA C800 and as follows:

1. Minimum working pressure rating of all service line material shall be 150 psi.

2. All water works materials provided shall be rated for the test pressures indicated for the water main and as specified in Section 331300, Testing and Disinfection of Water Utility Pipelines.

B. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 WATER PIPING AND FITTINGS

A. Copper Tubing:

1. Comply with ASTM B88.

2. Type K, annealed, seamless.

3. Fittings: Cast bronze alloys, threaded. Conform to ASTM B584, meeting “lead free” requirements above, and ASME B16.15.

    a. Mechanical surfaces shall have a 100% machine finish with no gaps or low spots due to insufficient parent material.

    b. All fittings shall either be stamped or embossed with the manufacturer’s name.

    c. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

    d. Manufacturers:

        1) Ford.
        2) Mueller.

4. Joints: Compression.

2.3 CORPORATION STOP ASSEMBLIES

A. Corporation Stops:

1. Body: Bronze alloy.

2. Valve Type: Ball.

    a. Comply with section 02490.30 of the Special Provisions.

3. Direct Tapping: Corporation stops for direct tapping shall have AWWA tapered thread inlet and outlet connections compatible with service piping specified.

4. Less Than or Equal to 1-Inch Diameter:

    a. Inlets: AWWA tapered thread or male iron pipe thread.

    b. Outlets: Connections compatible with either copper or polyethylene tubing.

    c. Thread patterns for the saddle outlet and corporation stop inlet shall be compatible for proper installation.

5. Greater Than 1-Inch Diameter:

a. Inlets: Male iron pipe thread.
b. Outlets: Connections compatible with connecting service pipes.

B. Service Saddles:

1. Material: Comply with section 02490.20 of the Special Provisions.

2. Coating: Epoxy or nylon.

3. For Services Less Than or Equal to 1-Inch Diameter:

a. Single strap.
b. AWWA “CC” tapered thread.

4. For Services Greater Than 1-Inch Diameter:

a. Single strap.
b. Female pipe thread outlet.

5. Designed to hold pressures in excess of pipe working pressure.

6. Saddles used on PVC shall be formed for PVC pipe and shall have flat, stainless steel straps.

C. Manufacturers:

1. Mueller.
2. Or approved equal.

2.4 CURB STOP ASSEMBLIES

A. Curb Stops:

1. Body: Bronze alloy. Comply with ASME B16.15.

2. Valve Type: Ball.

a. Comply with Section 02490.30 of the Standard Specifications.

3. Sealing: Positive pressure.

B. Manufacturers:

1. Mueller.
2. Or approved equal.

2.5 METER SETTING EQUIPMENT

A. Description:

1. Height: 12 inches.

2. Material: Copper.

3. Construction:

a. Angle meter stop with drilled padlock wing.

b. Angle check valve.

c. Inlets and Outlets: Horizontal setting, with matching couplings, fittings, and stops.

4. Furnish test valves.

5. For services 1-inch and smaller:

a. Meters saddle nuts for installation and removal of meter.

6. For services greater than 1-inch:

a. Equip with a locking bypass.

B. Manufacturers:

1. Ford.
2. Mueller.

2.6 WATER METERS

A. Furnished and Installed by Owner.

2.7 BACKFLOW PREVENTERS

A. As specified in Section 40 05 13, Common Work Results for Process Piping.

2.8 SAMPLING STATIONS

A. Manufacturers:

1. Kupferle Foundry Company, Eclipse No. 88.

B. Sampling Stations:

1. Enclosure: Cast-aluminum. Lockable, non-moveable.

2. Interior Piping: Brass, 3/4-inch diameter FIP.

3. Exterior Piping: Galvanized steel, 3/4-inch diameter FIP. Depth of bury as shown in the Drawings.

4. Vent Tube: Copper, with 1/4-inch diameter pet cock.

2.9 UNDERGROUND PIPE MARKERS

A. As specified in Section 33 11 10, Water Utility Distribution Piping.

2.10 METER BOXES

A. As specified in Section 33 05 17, Precast Concrete Valve Vaults and Meter Boxes.

2.11 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Type S1, as specified in Section 31 05 13, Soils for Earthwork.

PART 3 EXECUTION

3.1 GENERAL

A. All service lines shall be installed continuous, without joints or splices, complete from the new water main (insulating corporation stop) to the new meter location or as otherwise shown.

B. Install service pipelines perpendicular to the main, unless shown otherwise.

C. Install service runs parallel to existing services with a perpendicular distance of 2 feet, minimum to 5 feet, maximum from existing services and a minimum perpendicular distance of 18 inches from property line for new services.

D. For service renewals, terminate service run inside of existing meter box as described below.

3.2 INSTALLATION

A. Construct the depth of trench for service connection piping to provide a minimum of 30 inches of cover over the top of the pipe, unless otherwise shown.

B. Excavation, backfill and surface restoration shall be performed in accordance with provisions stated in Section 31 23 17, Trenching.

C. Do not damage the main in any way during the excavation.

D. Water Main Tap

1. All taps to live water mains shall be made by the City's Water Division. Contractor shall coordinate with the City for tapping the water line for the water service connection.

E. Piping

1. Cut service pipes using tools specifically designed to leave a smooth, even, and square end on the material being cut.

2. Ream cut ends to the full inside diameter of the pipe.

3. Clean pipe ends to a sound, smooth finish prior to using compression connections which seal to the outside surface of the pipe.

F. Water Meters:

1. Water meter and tailpiece to be furnished and installed by the City's Water Division.

G. Backflow Preventers:

1. Install backflow preventers where indicated on Drawings and according to manufacturer instructions.

2. Testing and Installation Requirements: Comply with local water company requirements and plumbing codes.

H. Service Connections:

1. Install water service according to details in the Drawings.

2. Water meters and angle meter valve to be in precast concrete meter boxes as specified in Section 33 05 17, Precast Concrete Valve Vaults and Meter Boxes

3. Locate meter boxes as shown in the Drawings. Final location to be determined in the field by Engineer.

I. Service Renewal:

1. Install service line and angle meter stop from the water main to the inside of existing meter box location.

2. Where service renewals are to be connected to existing meters, stub up and terminate service run at angle meter stop where shown.

3. Where no meter is to be installed, place angle meter stop at 18 inches from face of curb with 12 inches to the springline in an approved box.

4. Owner will connect all service lines at the new meters or to existing service piping as shown.

5. Adjust meter box to finished grade after the service piping has been installed and surface has been restored to the satisfaction of the Engineer.

J. Trenchless Installation:

1. All water service installations under existing pavement, curbs, sidewalks or other surface improvements may be installed by trenchless construction techniques at Contractor option where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.

2. The Owner's Representative must approve all trenchless installation methods.

3. Where trenchless pipe installation is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks and other surface improvements whose replacement is avoided by use of a trenchless method, such as tunneling.

K. Service Abandonment

1. Contractor shall provide all excavation, shoring, surface restoration and labor for abandonment of services at the water main except that the actual abandonment at the corp stop can only be completed by the City's Water Division.

2. The City's Water Division shall remove all water meters for abandonment.

3. Contractor shall remove the meter box and dispose of. Contractor shall abandon all service piping as shown on the plans.

3.3 CORROSION PROTECTION

A. Install cathodic protection items where required, including dielectric insulating corporation stops, dielectric insulating joints, tape wrap, and grounding rod in accordance with Section 264201, Pipeline Cathodic Protection Systems.

3.4 FLUSHING AND DISINFECTION

A. Flush and disinfect all service connections and appurtenances in accordance with Section 331300, Testing and Disinfection of Water Utility Distribution Pipelines.

3.5 FIELD QUALITY CONTROL

A. Pressure test water distribution system according to AWWA C600 and Section 33 11 10, Water Utility Distribution Piping.

B. Compaction Testing for Bedding: See Section 33 11 10, Water Utility Distribution Piping for compaction testing requirements. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION

SECTION 33 13 00 - TESTING OF UTILITY PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hydrostatic pressure testing of utility systems piping, fittings, and valves.

B. Section Includes:

1. Pressure testing and disinfection of potable water distribution and transmission piping systems and appurtenances.

2. Testing and reporting of results.

C. Related Requirements:

1. Section 33 12 13 - Water Service Connections
2. Section 33 31 10 – Sanitary Utility Sewerage Piping

1.2 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA B300 - Hypochlorites
2. AWWA B301 - Liquid Chlorine
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances
4. AWWA C605 - Underground Installation of PVC and PVCO Pressure Pipe and Fittings
5. AWWA C651 - Disinfecting Water Mains
6. AWWA C655 - Field Dechlorination

1.3 SUBMITTALS

A. Section 01 33 00 –Submittals Procedures: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Pipeline Testing and Disinfection Plan: To be submitted for review and approval by the Engineer a minimum of 1 month before testing is to start. As a minimum, the plan shall include the following:

1. Testing schedule.

2. Hydrostatic Testing Plan:

    a. Narrative of the proposed process.
    b. Proposed equipment to be used.
    c. Disposal location for excess water used to fill mains.

3. Proposed testing locations.

4. Proposed plan for water conveyance, including flow rates.

5. Proposed plan for water control.

6. Proposed plan for water disposal, including flow rates. Include proposed plan for dechlorination of disinfection water, including discharge points.

7. Proposed measures to be incorporated in the project to minimize erosion while discharging water from the pipeline.

1.4 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All test equipment, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future functions.

B. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.

C. As a minimum, furnish the following equipment and materials for the testing:

Amount	Description
2	Graduated containers approved by the Engineer.
1	Hydraulic pump approved by the Engineer with hoses, valves, and fittings as needed and required for the testing and disinfection of the facilities.
1	High range chlorine test kit, as approved by Engineer, with digital readout. Range of detection shall be between 5 and 200 ppm. Accuracy of 3 percent.

2	Pressure gauges with pressure range at least 120 percent greater than the required maximum test pressure with graduations in 2 pounds per square inch (psi) increments. Gauges shall have been calibrated with 90 days of pressure testing.

PART 3 EXECUTION

3.1 HYDROSTATIC TESTING OF UTILITY PIPING

A. Make all necessary provisions for conveying water to the points of use and for the disposal of test water.

B. No section of the pipeline shall be hydrostatically tested until backfill has been placed, compacted, and passed required density testing and all field-placed concrete or mortar has attained full strength.

1. At the Contractor's option, early strength concrete may be used when the full-strength requirements conflict with schedule requirements.

2. All such substitutions and installations shall be approved by the Engineer prior to installation.

C. Provide 72-hour notification to the Engineer and Owner prior to conducting hydrostatic testing.

1. Provide coordination and scheduling required for the Owner and Engineer to witness and provide necessary labor for operating Owner's existing system during hydrostatic testing and disinfecting procedures.

2. The Contractor shall not operate any part of the existing water systems.

D. Pipe Filling:

1. Fill pipes slowly from the lowest elevation to highest point along test section with potable water.

2. Take all required precautions to prevent entrapping air in the pipes.

3. Allow for natural absorption of water by the lining of the pipe to occur.

4. Apply specified test pressure by pumping.

E. Testing of Force Mains:

1. Ductile Iron: In accordance with AWWA C600.

2. Polyvinyl chloride (PVC): In accordance with AWWA C605.

3. General:

    a. Tests shall be conducted under a hydrostatic test pressure not less than 1.25 times the stated anticipated maximum sustained working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section, minimum 150 psi, unless otherwise shown in the Drawings.

    b. In no case shall the test pressure exceed the rated working pressure for any joint, thrust restraint, valve, fitting, or other connected appurtenance of the test section.

    c. Testing shall be performed by applying the specified test pressure by pumping.

    d. Once the test pressure has been attained, the pump shall be valved off.

    e. The test will be conducted for a 2-hour period with the allowable leakage not to exceed the value as calculated per the Allowable Leakage formula below.

    f. During the test period, there shall be no appreciable or abrupt loss in pressure.

4. Allowable Leakage:

    a. Flanged Joints: Pipe, fittings, and valves with flanged joints shall be completely watertight. No leakage allowed.

    b. Mechanical or Push-on Joints: Pipe, fittings and valves with rubber gasketed joints shall have a measured loss not to exceed the rate given in the following Allowable Leakage formula:

$$AL = \frac{LD(P)^{1/2}}{148{,}000}$$

In the above formula:

AL = Allowable leakage, in gallons per hour
L = Length of pipe tested, in feet
D = Nominal diameter of pipe, in inches
P = Average test pressure during the leakage test, in pounds per square inch.

5. Maintaining Pressure:

    a. During the test period, operate the pump as required to maintain pressure in the pipe within 5 psi of the specified test pressure at all times.

b. At the end of test period, operate the pump until the specified test pressure is again obtained.

1) The pump suction shall be in a clean, graduated barrel, or similar device or metered so that the amount of water required to restore the test pressure may be accurately measured.

2) Sterilize this makeup water by adding chlorine to a concentration of 25 milligrams per liter (mg/L).

c. The Engineer will determine the quantity of water required to maintain and restore the required pressure at the end of the test period.

d. Each hour's loss stands on its own and will not be averaged.

6. Defects, Leakage, Failure:

a. If the test reveals any defects, leakage in excess of the allowable, or failure, furnish all labor, equipment, and materials required to locate and make necessary repairs.

b. Correct any visible leakage regardless of the allowable leakage specified above.

c. All leaks shall be repaired in a manner acceptable to the Engineer.

d. The testing of the line shall be repeated until a test satisfactory to the Engineer has been achieved.

3.2 TESTING OF UTILITY END CONNECTIONS AND TIE-INS

A. Connection of the new piping and appurtenances to the existing system shall be made and checked for leakage:

1. During the system startup, the Engineer and Contractor shall visually inspect all new fittings, piping, valves and appurtenances for evidence of leakage.

2. Any leakage observed during this period shall be promptly repaired by the Contractor, at Contractor's expense, as required by the Engineer.

END OF SECTION

SECTION 33 31 10 - SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials, manholes, and accessories normally used with gravity sanitary sewers and sanitary force mains.

B. Section includes:

1. Sanitary sewerage pipe and fittings.
2. Pipe markers.
3. Connection to existing manholes.
4. Manholes.
5. Wye branches and tees.
6. Sanitary laterals.
7. Bedding and cover materials.

1.2 RELATED SECTIONS

A. Section 03 21 00 - Reinforcing Steel
B. Section 03 30 00 – Cast-In-Place Concrete Work
C. Section 03 60 00 - Grouting
D. Section 09 09 00 – Painting and Coating
E. Section 31 05 13 - Soils for Earthwork
F. Section 31 05 16 - Aggregates for Earthwork
G. Section 31 23 16 - Excavation
H. Section 31 23 17 - Trenching
I. Section 31 23 23 - Fill
J. Section 33 01 30.13 - Sewer and Manhole Testing
K. Section 33 05 13 – Manholes and Wet Wells

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

6. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

7. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

8. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

9. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

11. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

13. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

15. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

17. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

7. AWWA C153 - Ductile-Iron Compact Fittings.

8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

1.4 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

B. Shop Drawings:

1. Indicate layout of sewer system and appurtenances.
2. Show size, materials, components of system, and burial depth.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.

2. Submit detailed description of procedures for connecting new sewer to existing sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Materials:

1. Unless otherwise noted, all water works materials provided for the project shall be new, of first-class quality and shall be made by reputable manufacturers.

2. All material of a like kind shall be provided from a single manufacturer unless otherwise approved by the Owner's Representative.

3. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage, and handling.

4. All pipe and fittings shall be manufactured in the United States of America, unless otherwise approved by the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust, and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 SANITARY SEWERAGE PIPE AND FITTINGS

A. Plastic Pipe:

1. Material:

a. Polyvinyl chloride (PVC), manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.

b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.

2. Fittings: PVC.

3. Pipe and fittings 4 inches to 15 inches in diameter:

a. Comply with ASTM D3034, SDR 35.

4. Pipe and fittings 18 inches and larger in diameter:

a. Comply with ASTM F679, PS46.
b. Pipe shall have a minimum stiffness of 46 pounds per square inch (psi).

5. AWWA C900 Pipe:

a. 4 inches to 12 inches in diameter.
b. DR 25.
c. Pipe shall have minimum stiffness of 149 psi.

6. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.

7. Joints:

a. Integral bell push-on type: Comply with ASTM D3212.

b. For use with AWWA C900 pipe: Integral bell push-on type: Comply with ASTM D3139.

8. Gaskets:

a. Factory installed.
b. Elastomeric gaskets: Comply with ASTM F477.

B. Ductile-Iron Pipe:

1. Comply with AWWA C151.

2. Minimum Special Thickness Class: 52.

a. Class 53 for flanged pipe as specified herein.

3. End Connections: Bell and spigot or plain, and as shown in the Drawings.

4. Outside Coating (buried):

a. Type: Asphaltic coating, minimum 1 mil uniform thickness.
b. Comply with AWWA C151.

5. Outside Coating (exposed):

a. Shop primed with coating meeting requirements of Section 09 90 00 Painting and Coating.

6. Lining (Pipe and Fittings):

a. Protecto 401 Ceramic Epoxy Lining.

7. Polyethylene encasement:

a. Comply with AWWA C105.

b. Polyethylene film shall be minimum 8-mil thick virgin linear low-density polyethylene (LLDPE).

8. Fittings:

a. Material: Ductile iron.

b. Comply with AWWA C153 or AWWA C110.

c. Lining: Protecto 401 Ceramic Epoxy Lining.

d. Coating: Meeting requirements of the adjacent ductile iron pipe.

e. Fittings shall be mechanical joint, push-on type, flanged or plain-end as required and shown on the Drawings.

f. All ductile-iron fittings and fitting joint restraints shall be wrapped in the field as follows:

1) Petroleum wax tape coating system:

a) Apply a wax tape coating system generally per AWWA C217 and consisting of three parts: surface primer, wax-tape, and outer covering. All three parts shall be the product of the same manufacturer.

b) The primer shall be a blend of petrolatum, plasticizer, and corrosion inhibitors having a paste-like consistency. It shall have a pour point of 100-degrees F to 110-degrees F and a flash point of 350-degrees. Use Trenton Wax-Tape Primer or approved equal.

c) The wax-tape shall consist of a synthetic-fiber felt, saturated with a blend of high-melt microcrystalline wax, solvents, and corrosion inhibitors, forming a tape coating that is easily formable over irregular surfaces and which firms up after application. The tape shall have a saturant pour point between 125-degrees F and 130-degrees F and a dielectric strength equal to a minimum of 100-volts per mil. Tape thickness shall be 50-mils to 90-mils in 6-inch wide rolls. Use Trenton No. 1 wax-tape or approved equal.

d) The outer covering shall consist of two layers of a plastic wrapper at total of one 150-gauge or three 50-gauge wound together as a single sheet. The plastic wrapper material shall consist of clear polyvinylidene chloride, high-cling membranes wound together as a single sheet. Use Trenton Poly-Ply or approved equal.

9. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

10. Joints:

a. Joint types shall be provided as identified in the Drawings and as required for the application.

b. Mechanical Joints:

1) Comply with AWWA C111.

c. Push-on Joints:

1) Comply with AWWA C111.

2) Manufacturers, without exception:

a) Tyton Joint by American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, McWane, and Pacific States Cast Iron Pipe.

b) Fastite Joint by American Cast Iron Pipe Company.

d. Restrained Joints:

1) Joint restraint for pipe shall be accomplished with an integral lock mechanism, except as may be otherwise specified.

a) Any such system shall be a manufacturer's standard proprietary design, shall be as recommended by the manufacturer for the application, and shall be performance proven.

2) Restraining components:

a) Ductile iron complying with AWWA C110 and/or C153, with the exception of a manufacturer’s proprietary design dimensions.

b) Push-on joints for such fittings shall comply with AWWA C111.

3) Deflection:

a) The maximum pipe deflection shall not exceed one half of the manufacturer’s stated joint deflection allowance.

4) Manufacturers:

a) “Fast Grip”, American Cast Iron Pipe Company.

b) “Field-Lok”, United States Pipe and Foundry Company.

c) “MEGALUG”, EBAA Iron, Inc.

(1) Where any restrained joint system requires the use of a wedge-type mechanical restraint gland for restraint, the glands shall be provided in quantities as may be required and shall be considered incidental to the joint restraint system.

(2) Wedge-type mechanical restraining glands shall not be used to restrain the plain end of plain end ductile iron or cast iron fittings.

d) Approved equal.

e. Flanged Joints:

1) Flat faced, complying with AWWA C115.

2) Bolt hole drilling according to ASME/ANSI B16.1, Class 125. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.

3) The Contractor shall coordinate with pipe, valve and fitting suppliers to make certain mating pipe, valve and fitting flanges match in bolt pattern.

4) AWWA flanges shall not be exposed to test pressures greater than 125% of rated capacity.

5) Threaded flanges:

   a) Ductile iron pipe spools with threaded flanges shall conform to AWWA C115.

   b) Installed only on pipe with a minimum Class 53 wall thickness.

6) Buried flanges:

   a) Flanged connections shall not be buried unless shown as such on the Drawings.

   b) Buried flanges shall be wrapped with 2 layers of 10 mil tape along edges of flanges.

7) Gaskets:

   a) Full faced, composed of synthetic rubber and 1/8-inch thick conforming to ASME B21.1 and AWWA C111.

   b) Ring gaskets will be permitted only where specifically noted in the Drawings and Specifications.

   c) Gaskets for flanged joints shall be as follows:

      (1) All pipe sizes with service pressures of 150 psi or less shall be Garlock 98206 or equal.

   d) Flanged insulating joints shall be as specified in section 40 05 13-Common Work Results for Process Piping.

C. Reinforced Concrete Pipe:

1. Comply with ASTM C76, Class V, with Wall Type C.

2. Reinforcement: Mesh.

3. End Connections: Bell and spigot.

4. Fittings: Reinforced concrete.

5. Joints:

    a. Rubber compression gasket.
    b. Comply with ASTM C443.

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two [Series 300] stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00, Cast-in-Place Concrete.
2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcing.

2.5 MANHOLES

A. Description:

1. As specified in Section 33 05 13 - Manholes.
2. Material: Precast concrete.
3. Diameter: As shown in the Drawings.
4. Top: Eccentric cone.
5. Frames and Covers: Watertight cast iron.
6. Cover Inscription: S

2.6 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Type S1 and/or S2, as specified in Section 31 05 13, Soils for Earthwork.

2.7 MIXES

A. Grout: As specified in Section 03 60 00, Grouting.

2.8 ACCESSORIES

A. As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut, or excavation base is ready to receive Work.
B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.

3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Engineer prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Provide sheeting and shoring as specified in Section 31 50 00 Excavation Support and Protection.

6. Placement:

a. Place bedding material at trench bottom.
b. Level materials in continuous layer not exceeding 6 inches compacted depth.
c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

a. PVC: Comply with ASTM D2321.
b. Ductile Iron: Comply with AWWA C600.
c. Reinforced Concrete: Comply with ASTM C1479.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated on Drawings.

4. Variations:

a. Maximum Variation from Indicated Line: 1/32-inch per inch of pipe diameter, but no more than 1/2-inch, providing that such variation does not result in a level or reverse-sloping invert.

b. Maximum Variation from Indicated Grade: 1/32-inch per inch of pipe diameter, but no more than1/4-inch.

c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64-inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Engineer.

7. Make straight field cuts without chipping or cracking pipe.

8. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.

9. Assemble pipe joints in accordance with manufacturer's recommendations/specifications.

10. Cap open ends during periods of Work stoppage.

11. Lay bell and spigot pipe with bells upstream.

12. Polyethylene Pipe Encasement: Conform to AWWA C105.

13. Backfill and compact as specified in Section 31 23 17, Trenching.

14. Do not displace or damage pipe when compacting.

15. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.

2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.

3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.

4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.

5. The pipe is then forced "home" firmly and fully.

6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Connection to Existing Manholes:

1. Drilling:

a. Core drill existing manhole to clean opening.

b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.

2. Install watertight neoprene gasket and seal with non-shrink concrete grout.

3. Encasement:

a. Concrete encase new sewer pipe minimum of 24 inches to nearest pipe joint.
b. Use epoxy binder between new and existing concrete.

4. Prevent construction debris from entering existing sewer line when making connection.

E. Manholes:

1. Install manholes as specified in Section 33 05 13, Manholes and Structures.

F. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

G. Sanitary Laterals:

1. Construct laterals from wye branch to terminal point at right-of-way or where otherwise shown in the Drawings.

2. Where depth of main pipeline warrants, construct riser-type laterals from wye branch.

3. Minimum Depth of Cover over Piping: 2 feet.

4. Minimum Separation Distance between Laterals: 5 feet.

5. Install watertight plug, braced to withstand pipeline test pressure thrust, at termination of lateral.

6. Marker Stake:

   a. Install temporary marker stake extending from end of lateral to 12 inches above finished grade.

   b. Paint top 6 inches of stake with fluorescent orange paint.

H. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Engineer prior to and immediately after placing bedding.

B. Testing:

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

2. Pipe Testing: As specified in Section 33 01 30.13, Sewer and Manhole Testing.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 41 10 - STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials and accessories normally used with gravity storm drainage sewers.

B. Section includes:

1. Storm drainage piping
2. Piping accessories
3. Connection to existing manholes
4. Catch basins and area drains
5. Cleanouts
6. Bedding and cover materials

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete Work
B. Section 03 60 00 - Grouting
C. Section 31 05 13 - Soils for Earthwork
D. Section 31 05 16 - Aggregates for Earthwork
E. Section 31 23 16 - Excavation
F. Section 31 23 17 - Trenching
G. Section 31 23 23 - Fill
H. Section 33 01 30.13 - Sewer and Manhole Testing
I. Section 33 05 13 – Manholes and Wet Wells

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

7. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

8. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

8. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

9. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

11. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

13. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

15. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

17. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

1.4 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.

2. Submit detailed description of procedures for connecting new storm sewer to existing storm sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust, and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Polyvinyl Chloride (PVC) Pipe:

1. Material:

a. Manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.

b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.

2. Pipe and fittings 4 inches to 15 inches in diameter, non-pressurized:

a. Comply with ASTM D3034, SDR 35.

3. Pipe and fittings 18 inches and larger in diameter, non-pressurized:

a. Comply with ASTM F679, PS46.
b. Pipe shall have a minimum stiffness of 46 pounds per square inch (psi).

4. AWWA C900 Pipe:

a. At locations shown in the Drawings.
b. Four inches to 12 inches in diameter.
c. DR 25.
d. Pipe shall have minimum stiffness of 149 psi.

5. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.

6. Joints:

a. Integral bell push-on type: Comply with ASTM D3212.

b. For use with AWWA C900 pipe: Integral bell push-on type comply with ASTM D3139.

7. Gaskets:

a. Factory installed.
b. Elastomeric gaskets: Comply with ASTM F477.

B. High Density Polyethylene (HDPE) Pipe:

1. Double wall, ribbed pipe with smooth interior.

2. Solid pipe, perforated pipe, and fittings shall meet the requirements of ASTM F-405 and F-667

3. Pipe 3 inches to 10 inches in diameter: Comply with AASHTO M-252.

4. Pipe 12 inches to 36 inches in diameter: Comply with AASHTO M-294.

5. Joints: Integral bell push-on type.

6. Manufacturers:

a. ADS, N-12 with Pro Link joints, or approved equal.

C. Acrylonitrile-Butadiene-Styrene (ABS) Pipe:

1. Single walled. Comply with ASTM D2680, SDR 23.5.

2. Perforated.

    a. Three-eighths-inch diameter holes, 3 inches on center.

3. Inside Nominal Diameter: 4 inches.

    a. Minimum Wall Thickness: 0.140 inches.

    b. One row of perforations on each side of pipe, approximately 45 degrees above bottom centerline of pipe.

4. Inside Nominal Diameter: 6 inches.

    a. Minimum Wall Thickness: 0.200 inches.

    b. Two rows of perforations on each side of pipe, approximately 45 degrees above bottom centerline of pipe.

5. Ends:

    a. Style: Bell and spigot.
    b. Type: Solvent sealed.

6. Fittings: ABS.

7. Joints:

    a. Type: Solvent weld.
    b. Comply with ASTM D2235.

D. Reinforced Concrete Pipe:

1. Comply with ASTM C76, Class V, with Wall Type C.

2. Reinforcement: Mesh.

3. End Connections: Bell and spigot.

4. Fittings: Reinforced concrete.

5. Joints:

    a. Rubber compression gasket.
    b. Comply with ASTM C443.

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two Series 300 stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 30 00, Cast-In-Place Concrete Work.
2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 30 00, Cast-In-Place Concrete Work.

2.5 MANHOLES

A. Description:

1. As specified in Section 33 05 13 - Manholes and Structures.
2. Material: Reinforced precast or cast-in-place concrete.
3. Diameter: As shown in the Drawings.
4. Top: Eccentric cone.
5. Frames and Covers: Watertight cast iron.
6. Cover Inscription: “S”.

2.6 CATCH BASINS AND AREA DRAINS

A. Construction:

1. Material: Reinforced precast or cast-in-place concrete.

a. Minimum compressive strength of 3,000 psi at 28 days.
b. Precast concrete inlets shall conform to ASTM C913.

2. Joints: Lipped male/female.

3. Nominal Interior Dimensions: As shown in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron.

2. Lid:

a. Removable.
b. Design: Linear grill.

3. Nominal Lid and Frame Size: As shown in the Drawings.

2.7 CLEANOUTS

A. Construction:

1. Per details provided in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron. Meet H20 load requirement.

2.8 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Type S1 and/or S2, as specified in Section 31 05 13, Soils for Earthwork.

2.9 MIXES

A. Grout: As specified in Section 03 60 00, Grouting.

2.10 ACCESSORIES

A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut, or excavation base is ready to receive Work.
B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Engineer prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Provide sheeting and shoring as specified in Section 31 50 00 Excavation Support and Protection.

6. Placement:

a. Place bedding material at trench bottom.

b. Level materials in continuous layer not exceeding 6 inches compacted depth.
c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

   a. PVC, HDPE, ABS: Comply with ASTM D2321.
   b. Ductile Iron: Comply with AWWA C600.
   c. Reinforced Concrete: Comply with ASTM C1479.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated on Drawings.

4. Variations:

   a. Maximum Variation from Indicated Line: 1/32-inch per inch of pipe diameter, but no more than 1/2-inch, providing that such variation does not result in a level or reverse-sloping invert.

   b. Maximum Variation from Indicated Grade: 1/32-inch per inch of pipe diameter, but no more than1/4-inch.

   c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64-inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Engineer.

7. Make straight field cuts without chipping or cracking pipe.

8. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.

9. Assemble pipe joints in accordance with manufacturer's recommendations/specifications.

10. Cap open ends during periods of Work stoppage.

11. Lay bell and spigot pipe with bells upstream.

12. Backfill and compact as specified in Section 31 23 17, Trenching.

13. Do not displace or damage pipe when compacting.

14. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.

2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.

3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.

4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.

5. The pipe is then forced "home" firmly and fully.

6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Connection to Existing Manholes:

1. Drilling:

a. Core drill existing manhole to clean opening.

b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.

2. Install watertight neoprene gasket and seal with non-shrink concrete grout.

3. Encasement:

a. Concrete encase new sewer pipe minimum of 24 inches to nearest pipe joint.
b. Use epoxy binder between new and existing concrete.

4. Prevent construction debris from entering existing sewer line when making connection.

E. Manholes:

1. Install manholes as specified in Section 33 05 13, Manholes.

F. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

G. Catch Basins

1. Form bottom of excavation clean and smooth, and to indicated elevation.

2. Cast-in-place Concrete Construction:

a. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe end sections.

b. Level top surface of base pad.

c. Sleeve concrete shaft sections to receive storm sewer pipe sections.

d. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

3. Mount lid and frame level in grout, secured to top cone section to indicated elevation.

H. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Engineer prior to and immediately after placing bedding.

B. Testing:

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

2. Pipe Testing: As specified in Section 33 01 30.13, Sewer and Manhole Testing.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 40 05 13 - COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section applies to the furnishing and installation of piping inside a building, structure, enclosure piping and miscellaneous yard piping.

B. Section Includes:

1. Process piping, fittings, and appurtenances
2. Plumbing materials and appurtenances
3. Pipe supports
4. Penetrations, sleeves, and seals

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete Work
B. Section 03 21 00 – Reinforcing Steel
C. Section 05 50 00 – Metal Fabrications
D. Section 09 90 00 – Painting and Coating
E. Section 31 23 16 – Excavation
F. Section 31 23 17 – Trenching
G. Section 33 05 17 – Precast Concrete Valve Vaults and Meter Boxes
H. Section 33 13 00 – Testing & Disinfecting of Utility Piping
I. Section 40 05 23 – Common Work Results for Process Valves

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.20.1 Pipe Threads, General Purpose (inch)

2. ASME A13.1 - Scheme for the Identification of Piping Systems.

3. ASME B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys

4. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250.

5. ASME B31.3 - Process Piping.

6. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile.

3. ASTM A325 - Specification for High-Strength Bolts for Structural Steel Joints.

4. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.

5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

7. ASTM D792 - Test Methods for Specific Gravity and Density of Plastics by Displacement.

8. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

10. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

11. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.

12. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

C. American Water Works Association:

1. AWWA C200 - Steel Water Pipe - 6 In. (150 mm) and Larger.

2. AWWA C207 - Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.

3. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

5. AWWA C510 - Double Check Valve Backflow Prevention Assembly.

6. AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly.

7. AWWA C606 - Grooved and Shouldered Joints.

8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Coordinate installation of specified items with installation of valves and equipment.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer catalog information for each product specified.

C. Shop Drawings:

1. Identification:

a. Submit list of wording, symbols, letter size, and color coding for pipe identification.

b. Comply with ASME A13.1.

2. Provide all necessary dimensions and details on pipe joints, restraints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists.

3. Provide detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, couplings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.

D. Manufacturer's Statement: Certifying pipe fabrication and products meet or exceed specified requirements.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS and ASME qualification within previous 12 months.

F. Manufacturer Instructions: Submit special procedures and setting dimensions.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping appurtenances.
B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Drawings:

1. Piping layouts shown in the Drawings are intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

B. Inspection:

1. All pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Welding:

1. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1.

2. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welders:

1. Skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used shall do all welding.

2. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local approved testing agency prior to commencing work on the pipeline.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. The Contractor shall furnish all material and bear the expense of qualifying welders.

E. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

1.8 MATERIAL DELIVERY, STORAGE AND INSPECTION

A. Inspection:

1. Accept materials on Site in manufacturer's original packaging and inspect for damage.

2. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition.

B. Storage:

1. Store materials according to manufacturer instructions.

2. Store materials off the ground, to provide protection against oxidation caused by ground contact

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.

3. Provide additional protection according to manufacturer instructions.

D. All defective or damaged materials shall be replaced with new materials.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

B. Unless specified otherwise or indicated differently in the Drawings, all process piping systems and materials shall be as listed in the table below or as shown on the Drawings:

Service	Material
Drainage/Sanitary Sewer	See Division 33.
Exposed ≥ 4"	Class 52 Ductile Iron, or Class 53 where specified
Buried ≥ 4"	Class 52 Ductile Iron
Submerged/Buried < 4"	Stainless Steel - Type 316 Schedule 40 Threaded - ASTM A 312 Fittings Welded or Threaded
Exposed < 4"	Brass - ASTM B 43, Fittings - Bronze - ASTM B 62 Threaded - ANSI/ASME B 16.15
Buried < 4"	Copper Tubing - ASTM B88 Type K Soft / Fittings - Wrought Copper - ANSI B16.22, Joints-Soldered
Miscellaneous Pipelines	As shown in the Drawings

2.2 FLANGED DUCTILE IRON PIPE AND FITTINGS

A. See Section 33 31 10, Sanitary Utility Sewerage Piping.

2.3 COPPER PIPE AND FITTINGS

A. Description:

1. Seamless; ASTM B88.

2. Type:

a. Type L, hard drawn.

b. For pipe under floor slabs, underground or cast in concrete: Type K, annealed, seamless.

B. Joints:

1. Compression.
2. Manufacturer: Mueller Model 110 or approved equal

C. Dissimilar Metals: See Dielectric Unions specified herein.

2.4 BRASS PIPE AND FITTINGS

A. Pipe: ASTM B43, chrome plated.

B. Fittings:

1. ASTM B584, brass.
2. ASTM B16.15.

C. Joints:

1. Mechanical compression.
2. Threaded: Tapered and smooth threads, ASME B1.20.1 and ASTM B43.

D. Dissimilar Metals: See Dielectric Unions specified herein.

2.5 FLEXIBLE TUBING

A. Polyethylene thermoplastic tubing:

1. Standard weight, conforming to ASTM D1248 Type 1, Class A, Category 4, Grade E5.

2.6 GALVANIZED STEEL PIPE AND FITTINGS

A. Pipe: Seamless, or electric resistance welded, ASTM A53, Schedule 40.

B. Joints: Threaded.

C. Fittings:

1. Threaded, 150 lb. malleable iron, galvanized, ASTM A197 or ASTM A47, dimensions conforming to ANSI B16.3.

2. Unions, 300 lb. malleable iron, galvanized with dimensions conforming to ANSI B16.3, brass to iron seat.

3. Thread lubricant shall be Teflon tape or joint compound that is insoluble in water.

D. Buried Service:

1. Galvanized pipes shall be spirally wrapped with polyvinyl chloride or polyethylene pressure sensitive tape, applied with a suitable primer.

2. The wrap shall have a nominal thickness of 20 mils, consisting of either one layer of 20-mil tape or two separate layers of 10-mil tape.

3. Before the primer and wrap is applied, the piping shall be thoroughly cleaned so that all surfaces shall be dry and free of dirt, dust, rust, oil scale, oil, grease, or other foreign matter.

4. Any solvents used shall be totally volatile so as to leave no trace of oil.

5. Weld spatters, burrs, or sharp points and edges shall be removed by chiseling, ball peening or filling.

6. After thorough cleaning, the piping shall be coated with a primer applied in accordance with the tape manufacturer's recommendations. Spiral wrappings shall be applied with an overlap of at least 1-inch.

2.7 STAINLESS STEEL TUBING AND FITTINGS

A. Type 316 stainless steel, unless otherwise specified or shown in the Plans.

B. Meet the material standards set forth in ASTM A269.

C. Fittings: ASTM A276 and ASTM A182.

1. Threaded fittings: National pipe thread meeting the requirements of ASME B1.20.1.
2. Compression fittings: Two-ferrule, mechanical grip design.

D. Unions: Provide to facilitate installation and maintenance of tubing.

E. Manufacturer:

1. Swagelock, or approved equal.

2.8 STAINLESS STEEL PIPE AND FITTINGS

A. Pipe:

1. Size: 4 inches and smaller, schedule 80, type 304, unless otherwise specified.
2. Conforming to ASME B36.19 dimensions.
3. Conforming to ASTM A312 material requirements.

B. Fittings: Conform to ASME B16.11 dimensions and ASTM A182 material requirements.

C. Threads: Conform to ASME B1.20.1.

D. Socket welds: Conform to ASME B16.11.

2.9 FLEXIBLE COUPLINGS

A. Description:

1. Sleeve-type, couplings. Comply with AWWA C219.

2. Minimum design pressure rating: 150 psi.

3. Middle Ring: As required for coupling based upon connecting pipe materials, steel or ASTM A536, ductile iron.

4. Followers: As required for coupling based upon connecting pipe materials, steel or ASTM A536, ductile iron.

5. Gaskets:

a. Material: Buna-N.
b. Comply with ASTM D2000.

6. Bolts:

a. Buried: Steel.
b. Submerged: Stainless steel.

7. Center Pipe Stop: Required where shown on the Drawings.

B. Finishes:

1. Buried Couplings, Bolts: Factory epoxy coated.

C. Manufacturers:

1. For ductile iron and steel pipe:

a. Dresser, Style 38.
b. Romac, Model 501.
c. Smith-Blair.

2. For PVC pipe:

a. Romac, Model 501 or approved equal.

3. For flanged steel and ductile pipe:

a. Dresser, Style 128 or approved equal.

2.10 RESTRAINED FLANGED COUPLING ADAPTERS

A. Description:

1. ASTM A536, ductile iron.

2. Flange bolt circles compatible with ANSI/AWWA C115/A21.15.

3. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges.

4. Capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

5. Safety factor of 2:1 minimum.

6. Manufacturer:

a. EBAA Iron, Series 2100 Megaflange or approved equal.

2.11 FLANGED INSULATING JOINTS

A. Set shall include a full faced gasket, a full length insulating sleeve for each flange bolt, and two insulating washers and two steel washers for each bolt.

1. Gaskets:

a. Full face, comply with ASME 16.21.

b. Non-asbestos and non-phenolic compressed sheet packing with nitrile rubber binder.

c. Manufacturer: Garlock, Style 3505, or equal.

2. Insulating sleeves:

a. G-10 glass epoxy.

b. Extend the full width of both flanges, except where one flange hole is threaded where the sleeve shall extend through one flange and the gasket.

3. Insulating washers:

a. G-10 glass epoxy.
b. 1/8-inch thickness.

4. Washers:

a. Buried: Cadmium plated steel.
b. Submerged: Stainless steel.

B. The complete assembly shall have an ANSI/AWWA pressure rating equal to or greater than that of the flanges between which is installed.

C. After assembly, the joint shall be tested for continuity. Electrical resistance between flanges and between each bolt and each flange shall be not less than 100,000 ohms.

2.12 INSULATING UNION

A. Description:

1. Material: Galvanized malleable iron with a ground joint.

2. Iron pipe threads: Conform to ANSI B2.1.

3. Insulations: Nylon, bonded and molded onto the metal body.

4. Union: Rated for the operating and test pressures of the pipe system.

5. Joint connections to copper alloy pipe and tube shall be copper solder or threaded brass ground joints.

6. Isolation Barrier: Impervious to water.

2.13 DISMANTLING JOINT

A. Description:

1. Comply with AWWA C219, where applicable.

2. Self-contained flanged restrained joint fitting, including both flanged components and sufficient harness bars to withstand the imposed thrust.

3. Design: No part of the restraint system extends outside the flange diameter. The internal bore shall match that of the pipe system.

4. Dismantling joints will allow for a minimum of 2 inches of longitudinal adjustment.

5. Furnish as a complete assembly consisting of spigot piece, flange adaptor, tie bars and gasket.

6. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system. Tie Rod diameter shall be compatible with the corresponding bolt diameter of the mating flange. The Tie Rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50% of the yield strength of tie rod material.

7. Pressure Rating:

   a. Determined by the flange configuration, and all commonly used flanges shall be available.

   b. Design pressure rating shall be equal to or greater than the mating flanges.

   c. Dismantling joints will be specially fabricated to accommodate pressure requirements with ANSI B16.5 or ANSI B16.47 300-pound class flanges, depending on size of dismantling joint.

8. Lining and Coating:

   a. Shop-applied fusion bonded epoxy coating applied by fluidized bed method, complying with the requirements of NSF 61 and AWWA C550 as applicable.

   b. As an alternative, a shop-coat primer suitable for field applied coatings can be supplied.

9. Flanges: Flat-faced, rated to pressure requirements as shown on the Drawings.

   a. Where design pressure is greater than 300 psi, flanges shall conform to ASME B16.5 and ASME B16.47 300-pound class.

B. Materials:

1. Spigot piece: Steel, ASTM A283 Grade C.

2. Flange adaptor:

a. Up to 12-inch diameter: Ductile iron, ASTM A536 Grade 65-45-12.
b. Above 12-inch diameter: Steel, ASTM A283 Grade C.

3. Tie bars: Stainless Steel.

4. Gasket: EPDM Grade E.

5. Nuts, Bolts and Washers: Type 316 stainless steel.

C. Manufacturer:

1. Romac or approved equal.

2.14 PIPE SUPPORTS

A. Floor Support for Pipe:

1. Flanged Pipe Support:

a. Construction:

1) Adjustable vertical pipe support, flange plate, extension pipe from base cup to top collar cup with threaded stud.

2) Bolts directly to flange.

3) Anchorable base plate.

b. Material: Stainless Steel

c. Manufacturers:

1) Standon - Model S89.

2. Cradle Pipe Support:

a. Construction:

1) Adjustable vertical pipe support with saddle strap, extension pipe from base cup to top collar cup with threaded stud.

2) Anchorable base plate.

b. Material: Stainless Steel

c. Manufacturers:

1) Standon - Model S92.

2.15 PIPE PENETRATIONS

A. Sleeves for Pipes through Walls and Floors:

1. Material: Galvanized steel.

2. Thickness: Schedule 40.

3. Inside surface of all wall sleeves shall be coated with coal-tar.

4. Annular space between penetrating pipe and wall sleeve shall be filled with an approved permanently flexible sealant.

5. Diameter of wall sleeve shall be as shown in the Drawings.

B. Mechanical Sleeve Seals:

1. Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2. Manufacturer: Link-Seal or approved equal.

C. Pipes Cast-In Walls and Floors:

1. Material: Ductile iron or steel pipe, as required by the Drawings and the intended service.

2. Diameter: As shown in the Drawings.

3. End Type: As shown in the Drawings.

D. Seep Rings:

1. Material: 3/8-inch thick steel plate conforming to ASTM A36, unless otherwise noted.

2. Inside diameter: Equal to the outside diameter of the pipe or sleeve to which it is attached plus 1/4-inch.

3. Outside diameter: As shown in the Drawings.

4. Attach to the pipe or sleeve by means of a continuous seal weld located on both sides of the ring.

E. Pipe to Structure Flexible Connector

1. A flexible pipe to structure connector shall be used in the connection of sanitary and drain sewer pipe to wet wells, precast manholes, catch basins and buildings.

2. The connector shall be the sole element relied on to insure a flexible watertight seal of the pipe to the manhole. No adhesives or lubricants shall be employed in the installation of the connector to the manhole.

3. The rubber for the connector shall comply with ASTM C923 and consist of EPDM and elastomers designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products from spills.

4. All stainless steel elements of the connector shall be totally non-magnetic, Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe which shall be Series 305 Stainless. The worm screw for tightening the steel band shall be torqued by a break away torque wrench available from the precast manhole supplier and set for 60-70 inch/lbs.

5. The connector shall be installed in the structure wall by activating the expanding mechanism in strict accordance with the recommendation of the connector manufacturer.

6. The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.

7. The connector shall be Kor-N-Seal or approved equal.

2.16 PIPE COATINGS

A. See Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.1 GENERAL

A. Furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors,

valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. Pipe shall be installed in accordance with good trade practice. The methods employed in handling and placing of pipe, fittings, and equipment shall be such as to ensure that after installation and testing they are in good condition. Should damage occur to the pipe, fitting or equipment, repairs satisfactory to the Engineer shall be made.

3.2 INSTALLATION

A. Interior Piping Systems:

1. Install non-conducting dielectric connections wherever joining dissimilar metals.

2. Establish elevations of buried piping outside valve vault to obtain not less than 3 feet of cover.

3. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting as specified in Section 09 90 00, Painting and Coating.

4. Install piping according to ASME B31.9.

5. Install unions downstream of valves and at equipment or apparatus connections.

6. Install brass male adapters each side of valves in copper piped system; solder adapters to pipe.

B. Pipe Supports and Hangers

1. Install pipe supports according to MSS SP-58 & ASME B31.10.

2. All pipe shall be secured in place by use of blocking, hangers, brackets, clamps or other approved methods, and the weight thereof shall be carried independently of pump casings or equipment.

3. Special hangers and supports are shown on the Drawings.

4. The Contractor shall be responsible for determining the location of and providing all additional supports.

5. Hanger supports shall be as noted below with at least one support adjacent to the joint for each length of pipe, at each change in direction and at each branch connection. Sufficient hangers shall be provided to maintain proper slope without sagging. Support spacing shall not exceed manufacturer's recommendations, nor as listed below.

Maximum Support

Pipe	Spacing (Feet)
Steel Pipe	
Under 3 inches	6
3 inches and Over	12
Cast or Ductile Iron	
Under 4 inches	6
4 inches and Over	12
Stainless Steel and Galvanized Iron	
Under 1-1/2 inches	4
1-1/2 inches to 4 inches	6
Over 4 inches	12
Copper Pipe	6
PVC Pipe	
Under 2-1/2 inches	4
2-1/2 inches and Over	6

6. Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment as well as to support the weight of the piping and contents unless other vertical support is shown, but in no case shall be more than 12 feet.

7. Provide adjustable hangers for all pipes, complete with adjusters, swivels, rods, etc. Size hangers to clear insulation and guide where required, as well as support piping. All rigid hangers shall provide a means of vertical adjustment after erection. Hanger rods shall be machine-threaded. Continuous threaded rods will not be allowed.

8. Clevis or band-type hangers (B-Line FIG B3100) or approved equal shall be provided as required. Strap hangers not permitted.

9. Provide floor stands, wall bracing, concrete piers, etc., for all lines running near the floors or near walls and which cannot be properly supported or suspended by the walls or floors. Pipe lines near concrete or masonry walls may also be hung by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.

10. Equipment shall be positioned and aligned so that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

11. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

C. Pipe Penetrations:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals or grout, as shown in the Drawings.

2. Whenever a pipe line of any material terminates at or through a structural wall or floor, install piping or sleeve in advance of pouring of concrete required for the particular installation.

3. Plastic pipe shall not be cast in concrete or masonry walls.

4. Set sleeves in position in forms and provide reinforcing around sleeves.

5. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.

6. Extend sleeves through floors 1 inch above finished floor level and caulk sleeves.

7. Pipe other than concrete, to be cast in water-bearing walls or more than four feet below grade shall have seep rings.

8. All buried piping entering structures shall have a flexible connection installed less than two feet outside the structure line or as close to the wall as practical.

3.3 CLEANING, TESTING AND DISINFECTION

A. Testing and Disinfection: Piping shall be hydrostatically tested, flushed, and disinfected as specified in Section 33 13 00, Testing and Disinfection of Piping.

END OF SECTION

SECTION 40 05 23.72 - MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes miscellaneous valves not included in other Sections for use in buried service, pump stations, and utility vaults.

B. Section Includes:

1. Combination air/vacuum valves.

1.2 RELATED SECTION

A. Section 05 50 00, Metal Fabrications
B. Section 09 90 00, Painting and Coating
C. Section 40 05 13, Common Work Results for Process Piping.
D. Section 40 05 51, Common Requirements Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.

4. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

5. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

1.4 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling Schedule: Indicate valve locations and nametag text.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and actuators.
B. Operation and Maintenance Data: Submit information for valves.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

B. Tools:

1. Furnish special wrenches and other devices required for Owner to maintain equipment.

2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.8 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve, and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 VACUUM RELIEF/AIR INLET VALVES

A. Description

1. Inlet Size: 4-inch diameter
2. Ductile-iron body and cover.
3. Stainless steel spring and valve float.
4. Vacuum relief valves shall contain an anti-slam mechanism.
5. Vacuum threshold pressure to open: 0.25 psi (2kPA).

B. Manufacturers

1. APCO 1500 or approved equal.

2.3 COMBINATION AIR/VACUUM VALVES

A. 2" or Smaller

1. Description:

a. Construction: Single body with combination air/vacuum valve and air release valve with non-slam single orifice attachment.

b. Inlet Size: As shown on Drawings.
c. Stainless Steel body and cover. Comply with ASTM A240.
d. Stainless steel orifice and float. Comply with ASTM A240.
e. Valves seats: Buna-N.

2. Manufacturers:

a. APCO ASU Series or approved equal

B. Larger than 2”

1. Description:

a. Construction: Dual-chamber where the primary screened chamber incorporates a vertical, tubular screen to prevent solids above 2mm from entering the float/seal chamber. Primary chamber shall have a removable lid to allow for filter replacement without removal of the valve body from the vault.
b. Inlet Size: Greater than 2-inch diameter, with a combination of primary and secondary seals to allow vacuum break.
c. Stainless Steel body and cover. Comply with ASTM A240.
d. Stainless steel orifice and float. Comply with ASTM A240.
e. Valves seats: Buna-N.

2. Manufacturers:

a. Odour Technologies VS-4 HF.

2.4 SOURCE QUALITY CONTROL

A. Testing Pressure-Reducing and Pressure-Sustaining Valves:

1. Leakage Testing:

a. Test each assembled valve hydrostatically at 1-1/2 times rated working pressure for minimum five minutes.

b. Test each valve for leakage at rated working pressure against closed valve.

c. Permitted Leakage: None.

2. Functional Testing:

a. Test each valve to verify specified performance.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves per manufacturer requirements and recommendations.

B. Install all valves with valve seats level.

C. Install protective strainers upstream of solenoid valves, pressure-reducing valves, and pressure-sustaining valves.

3.2 ATTACHMENTS

A. The attachments listed below, following “END OF SECTION”, are part of this Section.

1. Attachment 1 – Schedule for Miscellaneous Valves.

END OF SECTION

SECTION 40 05 51 – COMMON REQUIREMENTS RESULTS FOR PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes basic materials and methods related to valves commonly used for process systems, including pump stations, utility vaults, and water and wastewater treatment. This Section is to be used in conjunction with Section 40 05 23.72, Miscellaneous Valves, Section 40 05 61, Gate Valves, Section 40 05 62, Plug Valves, Section 40 05 64, Butterfly Valves.

B. Section Includes:

1. Valves.
2. Valve actuators.

1.2 RELATED SECTIONS

A. Section 03 30 00, Cast-in-Place Concrete Work
B. Section 05 50 00, Metal Fabrications
C. Section 09 90 00, Painting and Coating
D. Section 33 11 10, Water Utility Distribution and Transmission Piping
E. Section 40 05 13, Common Work Results for Process Piping
F. Section 40 05 61, Gate Valves
G. Section 40 05 64, Butterfly Valves
H. Section 40 05 51.24, Check Valves
I. Section 40 05 23.72, Miscellaneous Valves

1.3 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

3. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.

4. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International (ASTM):

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.

D. NSF International (NSF):

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling Schedule: Indicate valve locations and nametag text.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and actuators.
B. Operation and Maintenance Data: Submit information for valves.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

B. Tools:

1. Furnish special wrenches and other devices required for Owner to maintain equipment.

2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.8 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve, and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required and shown in the Drawings.

B. Operation:

1. Open by turning counterclockwise; close by turning clockwise.

2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

C. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.

D. Connecting Nuts and Bolts: Stainless steel.

2.3 RESILIENT-SEATED GATE VALVES

A. As specified in Section 40 05 23.15, Gate Valves.

2.4 RUBBER-SEATED BUTTERFLY VALVES

A. As specified in Section 40 05 64, Butterfly Valves.

2.5 VALVE ACTUATORS

A. All valves shall be furnished with manual actuators, unless otherwise indicated in the Drawings.

B. Valves in sizes up to and including 4 inches in diameter shall have direct acting lever or handwheel actuators of the manufacturer's best standard design.

C. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

D. Provide actuators with position indicators for shutoff valves 6 inches and larger.

E. Comply with AWWA C541 and C542, where applicable.

F. Furnish gear operators for valves 8 inches and larger, and chainwheel operators for valves mounted over 7 feet above floor.

G. Provide gear and power actuators with position indicators.

H. Gear-Assisted Manual Actuators:

1. Provide totally enclosed gears.
2. Maximum Operating Force: 60-pound-force (lbf).
3. Bearings: Permanently lubricated bronze.
4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

I. Handwheel:

1. Furnish permanently attached handwheel for emergency manual operation.

2. Rotation: None during powered operation.

3. Permanently affix directional arrow and cast OPEN or CLOSE on handwheel to indicate appropriate direction to turn handwheel.

4. Maximum Operating Force: 60 lbf.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

3.2 PREPARATION

A. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.

B. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 INSTALLATION

A. Install valves, actuators, extensions, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Clean field welds of slag and splatter to provide a smooth surface.

E. Install valves with stems upright or horizontal, not inverted.

F. Install valves with clearance for installation of insulation and allowing access.

G. Provide access where valves and fittings are not accessible.

H. Comply with Division 40 - Process Integration for piping materials applying to various system types.

I. Valve Applications:

1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

2. Install shutoff and isolation valves.

3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.

4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.

J. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

3.4 FIELD QUALITY CONTROL

A. Valve Field Testing:

1. Test for proper alignment.

2. If specified by valve Section, field test equipment to demonstrate operation without undue leakage, noise, vibration, or overheating.

3. Engineer will witness field testing.

END OF SECTION

SECTION 40 05 51.24 - CHECK VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Work in this Section includes check valves for use in water and wastewater facilities. Work includes the furnish and install of all swing and silent check valves, complete, as shown on the Drawings and specified herein, including coating and lining, appurtenances, operators, and accessories.

B. Section includes:

1. Swing check valves, 1-inch through 4-inch diameter.
2. Swing check valves, 4-inch diameter and larger.
3. Duckbill-style check valves.

1.2 RELATED SECTIONS:

A. Section 22 05 23 - General-Duty Valves for Plumbing Piping
B. Section 40 05 23 - Common Requirements Results for Process Valves

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings.

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM A536 - Standard Specification for Ductile Iron Castings.

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.

5. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

6. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

7. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.

8. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

C. American Water Works Association (AWWA):

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

D. NSF International (NSF):

1. NSF 61 - Drinking Water System Components - Health Effects.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. As required by Section 40 05 51, Common Requirements Results for Process Valves.

PART 2 PRODUCTS

2.1 SWING CHECK VALVES, 1-INCH THROUGH 4-INCH DIAMETER

A. Description:

1. Horizontal T-pattern style.
2. 200# WOG.
3. Capable of functioning in the vertical position.
4. Connections shall be standard threaded or threaded for fire hose connections where shown on plans

B. Materials:

1. Body Cap and Disc: Brass conforming to ASTM B584 C85400.

C. Manufacturer:

1. Figure 246 as manufactured by Red White Valve.

2.2 SWING CHECK VALVES, 4-INCH DIAMETER AND LARGER

A. Description:

1. Meeting requirements of AWWA C508.

2. Type: Swing, resilient-seated, with outside lever and adjustable weight.

3. Flow Area: Full open.

4. Mounting: Horizontal or vertical.

5. Shall close tightly when the pressure downstream of the valve disc exceeds the upstream pressure.

6. Working Pressure: 150 psi

7. Tight sealing, shockless in operation and absolutely prevent the return of water back through the valve.

8. The disc shall be attached to the sic arm by means of a center pin, disc nut, and washer providing 360-degree angular articulation but not rotation.

9. Pin Shaft:

    a. Discs shall be suspended from a non-corrosive hinge pin shaft that shall rotate freely without the need for external lubrication.

    b. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing.

10. End Connections: As shown on Drawings. End connections shall be rated to the working pressure requirements specified above.

B. Materials:

1. Body and Disc: Constructed of heavy cast iron conforming to ASTM A126 class B, or ductile iron conforming to ASTM A536.

2. Cover: Steel conforming to ASTM A36 or Ductile iron conforming to ASTM A536.

3. Disc Arm: Ductile iron conforming to ASTM A536.

4. Body Seat: Type 316 stainless steel or Bronze ASTM B62.

5. Disc Seat: Field-replaceable, NBR or Buna-N.

6. Hinge Pin and Key: Stainless steel.

7. Rubber Components: NBR or Buna-N.

8. Connecting Hardware: Stainless steel.

C. Finishes:

1. Epoxy lining and coating conforming to AWWA C550.

D. Manufacturer:

1. GA Industries, Figure No. 220-D.

2. Cla-Val, 585 Series.
3. Approved equal.

2.3 DUCKBILL-STYLE CHECK VALVES

A. Description:

1. Duckbill-style check valves shall allow fluid to discharge through the valve and prevent flow in the reverse direction.

2. The duckbill-style check valves shall be one-piece elastomer matric with internal fabric reinforcing designed for low cracking pressure and minimum headloss.

3. The duckbill-style check valve shall be provided in EPDM elastomer that is resistant to hydrogen sulfide and is designed for use in domestic wastewater. It shall be provided as a slip-on sleeve connection to a pipe end and fastened with stainless steel clamps.

B. Manufacturer:

1. Tideflex model TF-1.
2. Approved equal.

2.4 SOURCE QUALITY CONTROL

A. Testing:

1. Hydrostatically test check valves at twice rated pressure, in conformance with requirements of AWWA C508.

2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install check valves according to AWWA C508, Section 40 05 51 Common Requirements Results for Process Valve, and as recommended by manufacturer.

3.2 SERVICES PROVIDED BY MANUFACTURER'S REPRESENTATIVES

A. Provide the services of the valve manufacturer's representative to verify proper installation of the valves and to adjust the valves when construction is complete.

END OF SECTION

SECTION 40 05 61 - GATE VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes gate valves for use in buried service, pump stations, and utility vaults. Coordinate with Section 40 05 51, Common Requirements Results for Process Valves.

B. Section Includes:

1. Resilient-seated gate valves.

1.2 RELATED SECTIONS

A. Section 40 05 13, Common Work Results for Process Piping
B. Section 40 05 51, Common Requirements Results for Process Valves.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. American Water Works Association (AWWA):

1. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
2. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

E. NSF International (NSF):

1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. As required by Section 40 05 51, Common Requirements Results for Process Valves.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT-SEATED GATE VALVES

A. Description:

1. Comply with AWWA C509.

2. Minimum Pressure Rating:

a. Twelve-inch Diameter and Smaller: 200 pounds per square inch (gauge) (psig).
b. Sixteen-inch Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

a. Standard mechanical joint ends comply with ANSI/AWWA C111.

b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125. Comply with AWWA C115 & ASME 16.5.

1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C509 for manual valves.

5. Linings and Coatings:

a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

b. All internal and external ferrous surfaces.

c. Do not coat flange faces of valves.

6. Bi-directional flow.

B. Operation:

1. Non-rising stem.

2. Open counterclockwise when viewing the valve from above, unless otherwise indicated in the Drawings.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators, unless otherwise specified in Section 40 05 51, Common Requirements Results for Process Valves.

C. Materials:

1. Wedge:

a. ASTM A126, cast iron or ASTM A536, ductile iron.
b. Fully encapsulated with molded rubber.

2. Body and Bonnet:

a. ASTM A126, cast iron or ASTM A536, ductile iron.

3. Stem, Stem Nuts, Glands, and Bushings: ASTM B584, bronze.

4. Valve Body Bolting: Stainless steel.

D. Manufacturers:

1. Clow Valve Company.
2. M&H Valve.
3. U.S. Pipe.
4. American Flow Control.
5. Mueller Company.

2.3 SOURCE QUALITY CONTROL

A. Testing: Test gate valves according to AWWA C509.

PART 3 EXECUTION

3.1 INSTALLATION

A. As required by Section 40 05 51 - Common Requirements Results for Process Valves.
B. Install according to manufacturer's instructions.
C. Support valves in plastic piping to prevent undue stresses on piping.

END OF SECTION

SECTION 40 05 62 - PLUG VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes plug valves for use in water and wastewater treatment plants.

B. Section Includes:

1. Eccentric plug valves.

C. Related Requirements:

1. Section 40 05 51 - Common Requirements Results for Process Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.

3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International (ASTM):

1. ASTM A536 - Standard Specification for Ductile Iron Castings.

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

C. American Water Works Association (AWWA):

1. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.
2. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit catalog information, indicating materials of construction and compliance with indicated standards.

C. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

PART 2 PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:

1. DeZurik, Model PEF
2. Approved equal.

B. Description:

1. Type: Non-lubricated, eccentric.

2. Minimum Working Pressure: 150 pounds per square inch (gauge) (psig).

3. Ports: Round. Passage size shall be 100 percent of the full port area on all sizes for minimum pressure drop.

4. Stem Bearings: Self-lubricating.

5. Stem Seals: Neoprene; V-ring type.

6. Packing and Gland: Accessible and externally adjustable.

7. End Connections: ASME B16.1, flanged.

C. Operation:

1. Greater than 3 inches: Worm gear manual operators.

   a. Provide with handwheel, except when buried.
   b. Actuator mechanism shall be fully isolated from line media.

D. Materials:

1. Body: AWWA C517, cast iron.

2. Wall Thickness: AWWA C504.

3. Plug:

    a. AWWA C517, cast iron.

    b. ASTM A 536, ductile iron. lined with resilient coating as recommended by valve manufacturer for service conditions.

4. Seats: To match material of body.

5. Stem: Type 316 stainless steel.

6. Stem Bearings: Stainless steel.

7. Seals: Cartridge type with two O-rings, or V-cup type, self-adjusting, wear compensating. Packing shall be replaceable without removing the valve bonnet or plug.

8. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51, Common Requirements Results for Process Valves.

2.2 SOURCE QUALITY CONTROL

A. Performance Testing:

1. Operate each valve and actuator from fully CLOSED to fully OPEN to fully CLOSED under no-flow conditions.

B. Leakage Testing:

1. Test at indicated working pressure to ensure valves are drip tight. Test with pressure in both directions for 5 minutes each way.

C. Hydrostatic Testing:

1. Perform test at twice rated pressure. Test for at least 1-minute to ensure no leakage.

PART 3 EXECUTION

3.1 LOCATION

A. Valve and actuators shall be located and oriented as shown on the Drawings.

B. When not shown on the Drawings, coordinate positions and orientations of seats and actuators with the Engineer prior to installation.

3.2 INSTALLATION

A. Install valves according to Section 40 05 51, Common Requirements Results for Process Valves, AWWA C517 and as recommended by manufacturer.

B. Install plug valves in horizontal piping with the stem horizontal such that the valve seat is on the downstream side of the valve body and the plug is at the top of the valve when the valve is open; install plug valves in vertical piping with plug at top when closed.

C. Install such that plugs are on top when OPEN and on pressure side when CLOSED.

END OF SECTION

SECTION 40 60 00 - INSTRUMENTATION AND CONTROL

PART 1 GENERAL

1.1 SCOPE

A. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete and operational Instrumentation and Control System (System).

B. This section covers all work necessary for furnishing, installing, adjusting, testing, documenting, and starting up the System, including the interconnection and integration of components furnished under other sections of this contract.

C. Major constituents for the System include, but are not limited to, all materials, equipment, and work required to implement a complete and operating System. The System shall include primary elements for process variable measurements, analog display and control elements, and discrete display and control elements.

D. Additional constituents for the System include, but are not limited to, all materials, equipment and work related to implementing System communications. System communications includes sending and receiving data between components of the System and monitoring and alarming status of System components. This shall include the supply, installation, and testing of telephonic, radio, and networking components and cabling required for System operation, and components specified in this section.

E. Responsibility for Complete System:

1. The Contractor shall be ultimately responsible and shall provide for all labor, equipment, and materials not provided by others that are necessary for the supply, installation, certification, adjustment, testing, and start-up of a complete coordinated System that shall reliably perform the specified functions.
2. The Control Systems Integrator shall be responsible for providing and installing the Multismart and MAS 801 programming, providing a fully documented back-up electronic copy and printed copy of the controller logic program, and shall participate in the testing of the Multismart and MAS 801 systems and all associated field devices at start-up.
3. The Control Systems Integrator shall be responsible for providing and installing any required custom software programs as may be applicable; providing a fully documented back-up electronic copy and printed copy of each custom software program; and shall participate in the testing of the System and all associated field devices at start-up.

4. The Control Systems Integrator shall be responsible for providing and installing the Operator Interface program, providing a back-up electronic copy of the Operator Interface program, and shall participate in the testing of the Operator Interface system at start-up.
5. Both the Contractor and Control Systems Integrator shall coordinate their work to ensure that:

    a. All components provided under this section, whether Contractor provided or Owner Purchased Equipment, are properly installed.
    b. The proper type, size, and number of control wires with their conduits are provided and installed.
    c. Proper electric power circuits are provided for all components and systems.

6. Both the Contractor and Control Systems Integrator shall participate in the testing of all field devices at start-up.

1.2 STANDARDS

A. This Section incorporates the latest adopted revision of the following standards, by reference. In case of conflict between the requirements of this section and those of the listed standards, the more stringent requirements shall prevail:

1. NFPA – National Fire Protection Association:

    a. NFPA No. 70, NEC - National Electrical Code.
    b. NFPA No. 79, Electrical Standard for Industrial Machinery.

2. ISA – Instrumentation, Systems, and Automation Society.
3. ICS – NEMA (National Electrical Manufacturer's Association) Industrial Control and Systems including:

    a. ICS-1 – General Standards for Industrial Control and System.
    b. ICS-2 – Standards for Industrial Control Devices, Controllers and Assemblies.
    c. ICS-3 – Industrial Systems.
    d. ICS-4 – Terminal Blocks for Industrial Control Equipment and Systems.
    e. ICS-6 – Enclosures for Industrial Controls and Systems.

4. ANSI/IEEE – American National Standards Institute/Institute for Electrical and Electronics Engineers.
5. State and Local codes and ordinances.

6. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.):

   a. Standard 508 (Industrial Control Panels for General Use).
   b. Standard 698 (Industrial Control Panels Relating to Hazardous (Classified) Locations)
   c. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)

7. NETA – National Electrical Testing Association.

1.3 ELECTRICAL TESTING LABORATORY LABELING

A. All panels provided under this section shall be labeled by a Nationally Recognized Testing Laboratory (NRTL) of electrical systems, acceptable to the State of Washington; Underwriters' Laboratory (UL) and Electrical Testing Labs (ETL) are two such NRTLs. Labels shall be provided by an entity that is currently registered and authorized by the NRTL to provide such labels.

B. All panels provided under this section shall be acceptable to the State of Washington and the authority having jurisdiction.

C. All panels and components provided under this section shall conform to the more stringent of the technical specifications or the applicable NRTL standards (for example: UL standards 508, 698, and/or 913).

   1. Provide documentation necessary to verify that all components, construction methods, and circuits conform to the standard.
   2. Panels that use Intrinsically Safe (IS) devices (barriers and/or relays) and built to UL standards shall include documentation of UL standards 698 and/or 913, as applicable. Panels built to other equally acceptable NRTL standards (such as ETL) shall provide required documentation showing IS components and wiring are in compliance with that standard.

D. Contractor shall provide additional design, components, and equipment necessary to meet the requirements of the applicable NRTL standards.

E. Contractor shall provide submittals for additional components that are required by the applicable NRTL standards, but not specifically listed in this section.

1.4 SUBMITTAL DATA

A. Post-Contract Award Submittals: Submit shop drawings and equipment review data as specified in Division 1. In addition to the requirements of other Divisions and Sections of the specifications, the submittal information shall be provided within 30 days of award.

1. All submittals shall be made in an electronic, PDF format. All materials provided in the PDF submittals shall use standard paper sizes of 8.5” x 11”, 11” x 17”, or 22” x 34”. Sizes 11” x 17” and 22” x 34” are preferred for shop drawings, sketches, wiring diagrams, and similar, but may use 8.5” x 11” provided they are normally issued and/or are legible at that scale. Large spreadsheets may use the 11” x17” where required for legibility. All cut-sheets, descriptive material, technical data, and similar shall use 8.5” x 11”.
2. Where manufacturer’s standard literature with non-standard paper sizes are used, Contractor shall re-size such material to conform with the standard sizes listed.
3. Electronic submittals with non-standard paper sizes are subject to being returned, unreviewed, for non-compliance.

B. Submittals shall include, but not necessarily be limited to, the following:

1. All equipment to be supplied shall be listed followed by descriptive data sheets. The equipment list shall include each component name, manufacturer, model number, description of the operation, quantity supplied, and any special setup and operation and maintenance characteristics:

    a. Similar components used in the project shall be the product of a single manufacturer.
    b. Service and replacement components for all equipment shall be normally stocked and readily available from service centers and suppliers in Washington, Idaho, or Oregon.

2. Description and operation of all remote site hardware and the configuration features of the I/O and local control loop characteristics.
3. Catalog information, descriptive literature, wiring diagrams, and shop drawings on all electrical devices, components, panels, and enclosures furnished under this section.

4. Individual data (or specification) sheets shall be provided for all components provided under this section. The purpose of these data sheets is to supplement the generalized catalog information provided by citing all specific features for each specific component (e.g. materials of construction, special options included, calibration data including scale and range, etc.). Each component data sheet shall bear the component name and instrument tag number designation.
5. Panel elementary diagrams of pre-wired panels. Show all signals, analog and discrete, and all auxiliary devices such as relays, terminals, alarms, fuses, lights, fans, heaters, etc. Diagrams, device designations, and symbols shall be in accordance with NEMA ICS 1-101.
6. Panel elementary diagrams of panel assemblies. Show all signals, analog and discrete, and all auxiliary devices such as relays, terminals, alarms, fuses, lights, fans, heaters, etc. Diagrams, device designations, and symbols shall be in accordance with NEMA ICS 1-101.
7. Interconnecting wiring diagrams, with terminal identification numbers and external wire numbers, for the System. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes, motor control centers, etc.). This diagram shall be coordinated with the electrical contractor and shall bear his mark showing that this has been done. Diagrams, device designations, and symbols shall be in accordance with NEMA ICS 1-101.
8. Loop diagrams, with terminal identification numbers and external wire numbers for each control loop in the System. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes, motor control centers, etc.). This diagram shall be coordinated with the electrical contractor and shall bear his mark showing that this has been done. Diagrams, device designations, and symbols shall be in accordance with ISA Standards and Practices for Instrumentation.

C. In addition: Before any components are fabricated, and/or integrated into assemblies, or shipped to the site, the Contractor shall furnish to the Engineer, and receive his review of full details, shop drawings, catalog cuts, and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these Specifications. The decision of the Engineer upon the acceptability of any submittal shall be final.

D. The intent of the submittal is to ensure complete project scope coverage and does not relieve the supplier from fulfilling any specified requirements. The submittal shall consist of legible printed text and high quality CAD drawings, in PDF format, with descriptive bookmarks at all major and minor divisions of the document. The submittal shall address all hardware and software to be supplied:

1. Catalog information shall be submitted for all equipment, regardless of whether or not it is of the same manufacturer as that listed in the Specifications.
2. Where allowed requests for substitution must be made in writing and shall include corresponding copies of all literature and information required for evaluation of the proposed substitution. This must be done within 30 days of the contract award.

E. All submittals shall be complete, neat, and orderly. Partial submittals are not acceptable and may be returned, without being reviewed, for correction. All components shall be referenced by the instrument name tag designations.

F. If in the opinion of the Engineer a submittal is not clear, it will be returned to the Contractor and it shall be revised and resubmitted within 15 days:

1. When a resubmittal is requested, resubmit only the indicated deficient portions of the submittal in question or where changes have been made to previously acceptable items. Resubmitting previously acceptable items slows the review process as all resubmitted material is (re)reviewed.

G. Requests for equipment substitutions will be reviewed during the submittal process. Requests for equipment substitution received prior to the bid opening date will not be reviewed.

1.5 OPERATIONAL AND MAINTENANCE (O&M) MANUALS

A. The Contractor shall provide (1) electronic copy (in PDF format), and two (2) printed (loose-leaf) copies of detailed sets of Operation and Maintenance (O&M) manuals with complete information concerning the operation of the System within 30 days after start-up of the equipment. The O&M manuals shall include information related to diagnosis, down to the module and card replacement level.

B. The manuals shall include all project specific information and the printed copies shall be furnished in three-ring binders with indexed tab sections. The PDF copy shall have descriptive bookmarks at all major and minor divisions, similar to the indexed tabbed sections of the printed copies. The O&M Manuals shall contain descriptive material, drawings, and figures bound in appropriate places:

1. The manuals shall include operation and maintenance literature for the entire System and all components provided. The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, adjustment, calibration, and maintenance of each component provided.

2. The manuals shall include data sheets for all significant equipment used in the System. Significant equipment is defined as equipment performs a function other than simple interconnection. The data shall include, as a minimum, the component name, manufacturer, model number, quantity, and any special O&M characteristics:

    a. Factory calibration data sheets shall be included for all transmitters and transducers.
    b. Field calibration data sheets shall be included for all transmitters and transducers.

3. The manuals shall include wiring diagrams for all components provided. These wiring diagrams shall clearly show all terminals, terminal block number designations, and wire numbers. Diagrams, device designations, and symbols shall be in accordance with NEMA ICS 1-101.
4. The manuals shall include final as-built drawings (22" by 34" and 11" x 17" reduced) of equipment. These drawings shall include:

    a. Layout drawings for each panel shall include overall dimension details for each component and all door mounted operator devices including nameplate designations.
    b. Interconnecting wiring diagrams of all equipment installed or connected under this contract.
    c. Control loop diagrams showing operation of the System.

C. The manuals shall include a detailed functional description of the System. Control loops shall be fully described in the functional description. A detailed description of remote site features such as I/O and local control loops shall be included.
D. The manuals shall include final versions of the following software related items:

1. A fully documented back-up electronic copy of all controller logic programs, on non-magnetic media compatible with the System.
2. A fully documented printed copy of the controller logic program.
3. A fully documented back-up electronic copy of all custom software programs, on non-magnetic media compatible with the System.

E. The manuals shall include a listing of all recommended spare parts:

1. Spares and Expendables Recommendations: The Contractor shall provide a list of recommended spares and expendable items in sufficient quantities to sustain the System for a period of one (1) year after acceptance.

2. In addition to the Spares and Expendables List, the Contractor shall provide a Component Parts List. The Component Parts List shall be a complete parts list for the entire System and shall have the following features:

   a. the component types identified in a similar manner to the component identification code used in these Specifications.
   b. All components shall be listed with their exact and complete manufacturer's part number, including all options and accessories.
   c. All components shall be identified with their complete tag number as shown in these Specifications, or as modified or assigned by Contractor and approved by the Engineer.
   d. All components without tag numbers shall be grouped within component type by manufacturer's part number. Exact quantities shall be listed for each part number.

PART 2 PRODUCTS

2.1 GENERAL

A. Whenever any material, article, device, product, or fixture is indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, as shown on the drawings, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired. This procedure is not to be construed as eliminating from competition other products of equal or better quality by other manufacturers where fully suitable in design and shall be deemed to be followed by the words “or approved equivalent”. The decisions relative to equality shall be by the Engineer and Owner.

B. The design of the Instrumentation and Control System is based on the specific equipment specified hereinafter. For example, for equipment listed, the design is based on the named manufacturer. Should the Contractor select other equipment that requires different installation requirements, wiring and conduit, enclosures, accessories, etc., the Contractor shall obtain approval from the Engineer for such changes to the design in accordance with this Contract and shall make all approved changes at no additional cost to the Owner.

C. Analog signals shall be 4 to 20 mA DC, unless otherwise shown, conforming to the compatibility requirements of ISA Standard S50.1. Unless otherwise shown, circuits shall be Type 2 two-wire. Transmitters shall have a load resistance capability conforming to Class L. Transmitters and receivers shall be fully isolated. All instrumentation shall be compatible with the type of signal specified.

D. Discrete signals are two-state logic signals of two types: control and alarm. Control and alarm signals shall utilize 24 VDC or 120 VAC sources, as shown. Unless otherwise shown, all alarm signals shall open on alarm condition, and have isolated contacts rated for 5 amperes (minimum) at 24 VDC/120 VAC.

E. Nameplates, name tags, and service legends shall be used to identify all major components provided under this section. Major components are defined as components that perform a function other than simple interconnection:

1. Nameplates are defined as engraved rigid laminated plastic plates bearing the entire identifying text or ISA tag number of the component. Nameplates shall be securely mounted under or near a mounted component.
2. Name tags are defined as stamped stainless steel tags, unless otherwise noted, bearing the entire identifying text or ISA tag number of the component. Nametags shall be securely attached to the component.
3. Service legends are defined as engraved rigid laminated plastic legends bearing the entire identifying text or ISA tag number of the component integrally mounted on a panel face mounted instrument.
4. Service legends and panel interior mounted nameplates shall be black with white letters, and letter height shall be minimum 3/16-inch high characters, unless otherwise noted.
5. Panel exterior mounted nameplates shall be black with white letters, and letter height shall be minimum 3/8-inch high characters, unless otherwise noted.
6. Each panel assembly shall be provided with a face mounted engraved rigid laminated nameplate bearing the entire identifying text for the panel assembly. The nameplate shall be securely attached to the panel.

F. Wire labels are defined as machine printed heat-shrink tube type labels bearing the entire identifying text of the wire. Wire labels shall be furnished for all wires in each panel assembly provided. Label both ends of wires more than 6 inches in length. Label one end of wires less than or equal to 6 inches in length. Shrink labels in place with lettering in position to be easily read and no more than one (1) inch from the connecting terminal.

G. Terminal markers are defined as machine printed markers bearing the entire identifying text of the terminal. Terminal markers shall be furnished for all terminal blocks, fuse blocks, and grounding blocks provided. Securely mount terminal markers with lettering in position to be easily read.

H. Interposing relays, loop isolators, intrinsically safe barriers, and terminating resistors shall be furnished wherever necessary, as indicated by the instrument and/or installation, regardless of whether they are indicated in the drawings, to perform the functions shown herein and on the drawings.

I. All specified “industrial network equipment” shall comply with the following minimum specifications (Note: These requirements do not apply to non-industrial network equipment):

1. Rated for a 5-30VDC power supply.
2. UL listed.
3. Designed for an industrial environment.
4. Operating temperature of -40 degrees Fahrenheit to 176 degrees Fahrenheit.
5. IP66 rated water and dust resistant.
6. Control network device shall be capable of remote monitoring using OPC protocol.
7. All devices on fiber backbone shall have a minimum of two sets of transmit/receive ports.
8. Twisted pair network speed shall be a minimum of 100Base-TX.
9. Fiber optic network speed shall be a minimum of 100Base-FX.

2.2 PANEL ASSEMBLIES

A. Panel Assemblies shall be provided where indicated, specified, or required to meet the functional requirements of the System, as specified. Panel Assemblies shall be completely fabricated, instruments installed, and wired in the panel assembly manufacturer's factory. All wiring shall be completed and tested prior to shipment. All external connections shall be by way of numbered terminal blocks.

B. Panel Assembly Electrical:

1. Power Distribution:

a. Each panel will be provided with one or more 120 VAC, 60-Hz feeder circuits from the associated circuit breaker distribution panel provided under Division 26 – ELECTRICAL, unless otherwise shown. On each panel, make provisions for feeder circuit entry and provide circuit breakers, disconnects, and power distribution blocks as required for termination of the wires.

b. Provide circuit breakers as shown on schematic drawings. Circuit breakers shall be DIN rail mounted type.

c. Provide fuse blocks and fuses as shown on schematic drawings. Fuse blocks shall be DIN rail mounted, finger-safe type:

1) Provide blown fuse indication for all fused circuits.
2) Provide independent fuse block and fuse for each analog loop.
3) Provide independent fuse block and fuse for each PLC module.

2. Wiring:

a. All electrical wiring shall be in accordance with the applicable requirements of Division 26 – ELECTRICAL:

1) Wiring for discrete signal circuits shall be 600-volt class, PVC insulated, stranded copper, and shall be of the size required for the current to be carried, but not smaller than 16 AWG, enclosed in plastic wiring duct unless otherwise noted.

2) Wiring for analog signal circuits shall be 600-volt class, PVC insulated, stranded copper, twisted shielded pairs or twisted shielded triads, as required by the application, no smaller than No. 18 AWG, and shall be separated at least 6 inches from any power wiring.

3) Separate AC and DC wiring by a minimum of 6 inches where possible. Where AC and DC wires must be run together with less than 6 inches separation, provide grounded metallic barrier for separation between AC and DC wires. Where AC and DC wires must cross, make crossings at 90 degrees.

b. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at terminal blocks. All terminal blocks shall have terminal markers.

c. All interconnecting wires between panel mounted equipment and external equipment shall be identified per the requirements of Division 26 – ELECTRICAL.

d. All wires of a panel assembly shall have wire labels per the requirements of this section. This shall be done at all wire terminations including terminal blocks, I-O terminals (even if the number is duplicated on the terminal), and terminations on panel-mounted devices.

C. All components of the panel assemblies shall be identified with nameplates or service legends per the requirements of this section. Adhesive embossed plastic tape type labels are not acceptable.

D. Crate all panel assemblies with solid plywood sheeting and sufficient blocking and protective material to prevent damage during shipment and storage. Identify the contents of the crate with the full identifying text of the panel assembly, in block letters not less than two (2) inches in height, to allow the contents of the crate to be readily determined without opening the crate.

2.3 ENCLOSURES

A. Enclosures shall be provided as a Panel Assembly component where indicated, specified, or required to meet the functional requirements of the System, as specified.

B. Enclosures shall meet the following minimum specifications, unless otherwise noted:

1. NEMA 4 stainless steel.
2. Minimum metal thickness shall be 14-gauge.
3. All doors shall be rubber gasketed.
4. Wherever practical, enclosures shall be a manufactured item.
5. All enclosures that are to be structurally modified or shop fabricated shall be summarized, and the summary together with catalog cuts and/or shop drawings shall be submitted to the Engineer for approval prior to purchase or fabrication.
6. Enclosures shall be sized, provided with forced air ventilation, or provided with a cooling system to adequately dissipate heat generated by equipment mounted in or on the enclosure.
7. Enclosures over 59 inches in height shall be provided with a door switch and LED lighting package(s), unless otherwise shown.
8. Enclosure shall have the following accessories:

    a. Corrosion Inhibitor (Outdoor enclosures only)
    b. Stainless Steel Padlocking Handles
    c. Thermostat controlled Fan, Louvers, Vents/Screens (Indoor enclosures only, unless otherwise indicated).

C. Approved manufacturers include:

1. Saginaw
2. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.4 PRIMARY DISCONNECTS

A. Primary Disconnects shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. Primary Disconnects are defined as Circuit Breakers, Molded Case Switches, Fused Switches, Non-Fused Switches, Rotary Switches, and appurtenances by which the Panel Assembles can be disconnected from their source of supply:

1. All Primary Disconnects shall comply with Division 26 – ELECTRICAL.

2.5 CIRCUIT BREAKERS

A. Circuit breakers shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified:

1. All Circuit Breakers shall comply with Division 26 – ELECTRICAL.

B. Circuit breakers shall meet the following minimum specifications, unless otherwise noted:

1. Energy limiting design to protect downstream components better than conventional breakers during short circuits.
2. IP2x Finger protection
3. DIN rail mounted.
4. UL 489 approved.
5. UL 1077 approved.

C. Acceptable manufacturers and products include:

1. Allen-Bradley, Bulletin 1489.
2. Altech, UL Series
3. ABB, S2 Series
4. Weidmuller
5. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.6 FUSES

A. Fuses shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified:

1. All Fuses shall comply with Division 26 – ELECTRICAL.

2.7 POWER DISTRIBUTION AND GROUNDING BLOCKS

A. Power Distribution and Grounding Blocks shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified:

1. All Power Distribution and Grounding Blocks shall comply with Division 26 – ELECTRICAL.

2.8 SURGE SUPPRESSORS

A. Surge Suppressors shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. Surge Suppressors are intended to protect dedicated control equipment such as PLCs, Operator Interface Terminals, and instrumentation from high energy spikes in the electrical supply.

B. Surge Suppressors shall meet the following minimum requirements, unless otherwise noted:

1. 120 VAC single phase input voltage.
2. 47-63 Hz line frequency.
3. 20 Amp continuous rating.
4. All mode protection; L-N, L-G, N-G.
5. 330 VAC minimum Suppressor Classification per UL-1449-2
6. Form “C” status contact.
7. Response time (common mode) of 0.5 nsec. or less.

C. Approved manufacturers and products include:

1. Emerson/Control Concepts Islatrol IE-120.
2. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.9 TERMINAL BLOCKS

A. Terminal Blocks shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified.

B. Terminal Blocks shall meet the following minimum requirements, unless otherwise noted:

1. Single circuit, feed-through type
2. Two-level, feed through type for analog input signals, or where indicated.

3. DIN rail mounted.
4. Screw clamp connection.
5. Sized for the application, minimum 30 A rated.
6. 600 VAC/VDC rated.
7. It shall be possible to use a 'standard' instrument screwdriver blade on the terminal screws. Terminals which require 'reduced size' or 'tweak' screwdrivers to access terminals will not be accepted.

C. Approved manufacturers include:

1. Allen-Bradley.
2. ABB, type M4/6
3. Phoenix Contact Inc.
4. Weidmuller.
5. Similar units by other manufacturers may be considered for use on this project based on a comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.10 FUSE-HOLDING TERMINAL BLOCKS

A. Fuse-holding Terminal Blocks shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified.

B. Fuse-holding Terminal blocks shall meet the following minimum specifications, unless otherwise noted:

1. Single circuit, feed through type.
2. DIN rail mounted.
3. Screw clamp connection.
4. Sized for the application.
5. Blown fuse indication unless otherwise noted.
6. Contractor shall include appropriately sized fuses with all Fuse-holding Terminal Blocks.
7. It shall be possible to use a 'standard' instrument screwdriver blade on the terminal screws. Terminals which require 'reduced size' or 'tweak' screwdrivers to access terminals will not be accepted.

C. Approved manufacturers and products include:

1. Allen-Bradley, Bulletin 1492-WFB424/4250.
2. ABB, type M4/8 SFL
3. Phoenix Contact Inc., Type UK-5 HESI.
4. Weidmuller, type ASK.

5. Similar units by other manufacturers may be considered for use on this project based on a comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.11 POWER SUPPLIES

A. Power supplies shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. Power supplies shall convert 120 VAC, 60-Hz power to DC power of the appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that the components being supplied can operate within their required tolerances.

B. Power supplies shall meet the following minimum specifications unless otherwise noted:

1. DIN rail mounted finger-safe type.
2. Mounted such that dissipated heat does not adversely affect other components.
3. Input shall be rated for 82-132 VAC, 47-63 Hz.
4. Output shall be rated ±2% or less with 25 mV ripple phase to phase maximum.
5. Wiring connections shall be made via screw terminals. Solder lugs are not acceptable.
6. Protected against short-circuit, overload, over-voltage, and open-circuit type faults.
7. Sized as shown. Where a size is not shown, units shall be sized for the application, with a minimum of 10% spare capacity.

C. Approved manufacturers and products include:

1. Sola/Hevi-Duty, Type SDN-10-24-100P.
2. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.12 UNINTERRUPTABLE POWER SUPPLY (UPS) – 24VDC

A. Uninterruptable Power Supplies (UPSs) shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. UPS shall provide 24VDC back-up power for a limited duration should primary 24VDC power be lost. Provide number of battery modules as shown or required.

B. UPSs shall meet the following minimum specifications unless otherwise noted:

1. DIN rail mounted.
2. No internal fan or extra cooling required.
3. Flexible batteries back-up expansion capabilities.
4. User replaceable batteries.
5. Overload protection in both normal and battery modes
6. 24VDC input and 24VDC output.

C. Approved manufacturers and products include:

1. Sola/Hevi-Duty, Type SDU-10-24 and SDU-24-BAT.
2. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.13 AUXILIARY RELAYS/TERMINAL BLOCK RELAYS

A. Auxiliary relays shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. Relays shall be suitable for control, interfacing, and interposing functions.

B. Auxiliary Relays shall meet the following minimum specifications unless otherwise noted:

1. Plug-in general purpose, 3PDT minimum, power type relays rated for industrial use.
2. Equipped with a push-to-test button and indicator light.
3. Coil voltage shall match the control circuit voltage.
4. Contacts shall be 10 Amp, 120 volt (resistive) rated.
5. Mounted via DIN rail mounted, finger-safe sockets.

C. Terminal Block Relays shall meet the following minimum specifications unless otherwise noted:

1. Din-rail general purpose, 1PDT minimum, power type relays rated for industrial use.
2. Equipped with a supply voltage indicator light.
3. Coil voltage shall match the control circuit voltage.
4. Contacts shall be 6 Amp, 120 volt (resistive) rated.

D. Approved manufacturers and products include:

1. Allen-Bradley, Bulletin 700-HB/700-HLT.
2. Phoenix, PLC-RSC Series.

3. Similar units by other manufacturers may be considered for use on this project based on comparison to the listed products. Approval of substitutions is solely at the discretion of the Engineer.

2.14 FLYGT MULTISMART PUMP CONTROL SYSTEM

A. Functionality

1. The Pump Station Manager shall provide “Out of the box” 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:

   a. Functionality for advanced pump control of up to 3 pumps

   b. Pump mode, for each pump, between Auto/ Manual / Off

      1) In manual control (semi-automatic manual) pump switches off at deactivation setpoint and reverts to Auto mode to prevent accidental pump run on

      2) To pump beyond off set point in manual, button must be held down (full manual)

   c. Setpoint adjustment for pump activation/deactivation and level alarms

   d. Level device from 4-20mA, conductive probe or remote level

      1) Redundant level device handling

   e. Selectable between fill / empty

   f. Functionality for advanced pump control of up to 3 pumps including grouping and alternation

   g. Station optimization including

      1) Max off time (odour reduction): A timer that shall start a pump after the configured time has expired and will run one or more pumps to the pre-set off point

      2) Pump controller shall have a configurable maximum number of pumps allowed to run at a single time and whether to stop a running pump and start a lag pump or to prevent a lag pump to start.

3) Maximum starts per hour (pump protection)

4) Pump controller shall provide delays for the following

a) Start-start delay to prevent multiple pumps from starting at the same time and overloading electrical and hydraulic equipment

b) Stop-stop delay to prevent or reduce the effects of water hammer

c) Stop-start delay to prevent a pump from starting while a pump is ramping down and possibly damaging valves

d) Start-stop delay to prevent a pump from stopping shortly after a pump has started and possibly damaging valves

5) Pump controller shall shut a pump off and optionally set an alarm if a motor has been running longer than normal

6) Pump controller shall have configurable option to detect pump blockages and take action when a pump blockage occurs using one or more of the following options

a) Low power factor detection

b) Lag pump start counter

c) Low metered flow rate

7) Well washer controls

8) Pump controller shall have the ability to pump to the snore point using the following methods

a) Configurable amount of time to pump below the off point

b) Pump down to a configurable level point

h. "Locked level" alarm to indicate level device problem

1) User-defined % change within a time period

2) Different values for low use, high use times (user defined)

i. Alternation schemes including:

1) Fixed lead/duty

2) Alternation

3) Alternation N:1 (e.g., 3:1)

4) Alternation by hours run or starts

j. Decommissioned pump automatically removed from control algorithm, alarms, displays, etc

k. Six profiles of setpoints for spill management, off peak pumping, tariffing, etc

1) Automatic profile change on date/time

2) Selectable from SCADA, digital input, logic tag or faceplate

3) Profile includes some pump control parameters – max no of pumps, max run time, max off time

l. Datalogger for user-defined faults and events (process values)

1) 50,000 events to internal flash memory

2) 10,000,000 events by writing direct to Compact Flash card

3) Download event and fault log as csv to Compact Flash for Excel analysis

4) ftp transfer of event and fault log as csv for Excel analysis

m. 3-phase supply monitoring and supply protection

1) Under-voltage

2) Over-voltage

3) Phase fail

4) Phase rotation

n. Monitoring of dc supply, battery voltage, and internal temperature

o. Fault module with flexibility for any fault to

1) hold out pump(s) or be display only

2) auto-restart after user-defined time subsequent to fault condition clearing

3) auto-restart user-defined number of times (subsequent to fault condition clearing) before locking out

4) Manual/ SCADA reset required

p. Built in Web Server

q. Remote control via SCADA for

1) changing mode of pumps (auto/off/manual)

2) reset of pump and station faults

3) changing pump and alarm setpoints

4) changing setpoint profiles

r. Security

1) Admin user sets PINs for access to configuration of the unit

2) Automatic datalogging of who has entered the configuration menu

3) Automatic logging of all unsuccessful login attempts with date/time

4) Digital input option, e.g. key switch, for access to configuration menu

s. SD and USB port allows

1) Firmware upgrades

2) Save/load configuration (allows backup to be restored, or configuration copied from another station)

3) Download datalogger in CSV

4) Export/import Modbus and DNP3 points list in csv format

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.

C. Input/Output

1. The I/O shall be expandable to many hundreds of I/O points per unit.

2. 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)

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 paramameters.

2. The following parameters shall be displayed on the main screen:

a. Level in user definable units eg %, metres or custom units

b. Setpoints for alarms and pump start/stop

c. Pump running/stopped

d. Pump available/unavailable

e. Faults

f. 3-phase supply

g. Date/time

h. User-configurable option to display, flow rates, total starts, total hours run and other parameters

i. The screen will also have buttons to allow the user to access Faults, History, Information and Settings.

j. The following parameters shall be available via a user key press from the main screen:

1) Hours Run accumulators for each pump & the station with the following comparisons

a) last minutes run

b) this hour, last hour

c) today, yesterday

d) this week, last week

e) total hours run

2) Starts accumulators for each pump & the station with the following comparisons

a) this hour, last hour

b) today, yesterday

c) this week, last week

d) total starts

3) Flow values, either derived from calculations or via a flowmeter

a) Inflow

b) pump flow rate

c) total volume

d) overflow data, including start time, duration, estimated volume

4) Status of all I/O

a) Digital I/O open/closed and accumulator

b) Analog I/O mA and scaled

c) 3-phase voltage, frequency, phase angle

5) Database viewer to view all datapoints/tags in real time

6) Communications stats

k. 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.

1) 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.

2) A reset option for a fault will be presented to the user when faults can be acknowledged/reset.

l. The main screen shall include a History button which takes the user to a History screen

1) View all date/time stamped faults and events

2) Filter by pump or other station parameters, by time period

3) Export via CSV for analysis in Excel

m. The user interface should allow intuitive configuration of the system, including as a minimum:

1) Setup Wizard to allow a complete configuration (display, IO and configuration of functional blocks) by the user answering simple questions

2) Set-points, including alarm and pump setpoints

3) Enable/disable level alarms (so that for example, the low level alarm can be easily activated or deactivated)

4) Start, stop and alarm delays

5) Alternation/ fixed sequence and grouping of pumps where necessary

6) 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

7) 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

8) Pump station optimization parameters such as:

a) Max off time (odour 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

9) Supply protection

a) Under- and over-voltage alarm points

b) Volts phase imbalance and volts phase rotation

c) DC-supply alarm point

10) Communications ports, speeds and addresses

11) 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.

E. Communication

1. The product shall include:

a. Two Ethernet ports to 10Mbit/s

b. Two RS232 ports to 115kBit/s

c. Two RS485 ports to 115kBit/s

2. The system shall support a variety of media and communications networks including:

a. TCP/IP

b. UDP

c. RS232

d. RS485

e. Private radio over RS232

f. PSTN

g. Wireless LAN

h. Cellular data (via integral pppm module)

i. Cellular voice

F. The unit shall meet the following environmental ratings

1. Working temperature -10°C to +60°C

2. Storage temperature -40°C to +90°C

3. Humidity 5% to 95% (non-condensing)

4. IP Rating Controller: IP20, Nema 1

Display: IP65, Nema 4

G. Software Development:

1. The configuration for the system will be developed and provided by the Contractor.
2. Provide complete hardware and software manuals for the system including technical data on all individual components and installation and operation information.

2.15 INDUSTRIAL ETHERNET SWITCH

A. Industrial Ethernet switches shall be provided where indicated, specified, or required to meet the functional requirements of the System, as specified.

B. Industrial Ethernet switches shall meet the following minimum specifications, unless otherwise noted:

1. Switches shall be “unmanaged” type switches, supporting all IEEE 802.3 Ethernet protocols.
2. Switch shall be capable of supporting a minimum of 2048 MAC addresses.
3. 8 Port - Eight (8) auto-negotiation, auto-crossover, auto-polarity 10Base-T/100Base-TX (10/100Mbps) RJ45 ports. All ports shall be capable of both full and half duplex operation.
4. 5 Port / Fiber - Four (4) auto-negotiation, auto-crossover, auto-polarity 10Base-T/100Base-TX (10/100Mbps) RJ45 ports. All ports shall be capable of both full and half duplex operation. One (1) 100BaseFX Multimode Fiber Port with SC Connectors.
5. Switches shall have redundant power input terminals, capable of being powered by two different power sources. Input power shall be 18-30 Vdc.
6. Switches shall have a “status” output contact, rated 1 Amp (minimum) at 24 Vdc (nominal).

C. Approved manufacturers and products include:

1. N-Tron 308TX / 305FX-SC

2. Similar units by other manufacturers may be considered for use on this project based on comparison to these lines. Approval of substitutions is solely at the discretion of the Engineer.

2.16 FLOAT SWITCHES

A. Float switches shall be provided where indicated, specified, or required to meet the functional requirements of the System, as specified.

B. Float Switches shall meet the following minimum specifications, unless otherwise noted:

1. Direct-acting float type consisting of a mechanically activated (non-mercury) switch enclosed in a float and connected to a multi-conductor combination support and signal cable. The entire assembly shall form a completely watertight and impact-resistant unit.
2. Chemical-resistant polypropylene or other corrosion-resistant float material suitable for use in water and wastewater applications.
3. Cable shall be rugged and flexible with heavy neoprene or PVC jacket.
4. Actuation/deactuation differential shall be 1 inch minimum.
5. Switch shall be form C, rated at 5 amps (minimum) at 120 VAC.
6. Unit shall be suspended type and provided with length of cable required to reach panel or junction box without splicing. Contractor to verify length of cable required for each float switch before ordering:

    a. Float switches shall be provided with necessary brackets and clamps to suspend the unit from the top of a tank or vessel. The suspended type shall include an integral or attached weight assembly for stabilization and positive operation of the unit. All mounting clamps shall be PVC or Neoprene.

C. Approved manufacturers and products include:

1. ITT Flygt Corp., Model ENM-10.
2. Pulsar Inc., Model 800-70 Signal Master.
3. STI Corp., Series KA.
4. Warrick Controls Inc., Series M.
5. Similar units by other manufacturers may be considered for use on this project based on comparison to the listed products. Approval of substitutions is solely at the discretion of the Engineer.

2.17 LEVEL TRANSDUCER - SUBMERSIBLE PRESSURE TYPE

A. Submersible level transducers shall be provided where indicated, specified, or required to meet the functional requirements of the System, as specified.

B. Submersible level transducers shall meet the following minimum specifications, unless otherwise noted:

1. The submersible level transducer shall provide continuous liquid level measurement by sensing the hydrostatic pressure produced by the height of liquid above the transducer and providing a 4-20 mA output signal.
2. The transducer shall have a shielded cable with atmospheric vent tube and polyurethane jacket and shall be attached to the transducer using an over-molding process that prevents moisture intrusion. The transducer shall have a large 2.75 inch diameter PTFE flexible diaphragm surrounded by a 316 stainless steel non-fouling protective cage. Transducer shall utilize 316 SS construction. Accuracy shall be +/-0.25%. Transducer shall include UL and FM hazardous location approvals for intrinsically safe applications.
3. A desiccant vent filter shall be provided for installation in the Pump Disconnect Panel.

C. Approved manufacturers and products include:

1. Prosense model SLT-2 or equal. The range selected to match the wetwell depth and cable length as required to reach to the Pump Disconnect Panel.
2. The desiccant vent filter shall be Prosence model SLT-VF1 or equal.

2.18 SPECIALTY SWITCHES

A. Specialty Switches shall be provided where indicated, specified, or required to perform the functional requirements of the System, as specified.

B. Check Valve Limit Switch:

1. Limit switches on check valves shall be wobble stick actuator type. Use NO contact that will be held close when valve is not open (contact to be closed on no flow condition).
2. Contacts shall be 10 amp, 120 volt, resistive rated.
3. Approved manufacturers and products include:

    a. Allen-Bradley, Bulletin 802X
    b. Similar units by other manufacturers may be considered for use on this project based on comparison to the listed products. Approval of substitutions is solely at the discretion of the Engineer.

C. Hatch Security Switches:

1. Limit switches for intrusion detection on hatches shall be roller actuator type. Use NO contact that will be held closed when hatch is closed (signal opens on intrusion).

2. Contacts shall be 10 amp, 120 volt, resistive rated.
3. Approved manufacturers and products include:

    a. Allen-Bradley, Bulletin 802X
    b. Similar units by other manufacturers may be considered for use on this project based on comparison to the listed products. Approval of substitutions is solely at the discretion of the Engineer.

2.19 BACKUP LEVEL CONTROL

A. The Backup Level Control System shall consist of a Multitrode level probe in the wetwell, Intrinsically Safe barrier in the Air Gap Panel, and individual MTR / MTRA relays for each pump as shown on the drawings.

B. The probe shall be constructed from uPVC 32mm tubing with molded sensor units at regular intervals along the probe. Each sensor unit will be PVC injected to prohibit ingress of moisture, and the sensor material will be Avesta SMO254 stainless steel. 10 sensors will be spaced along the length of the probe assembly, and each will be individually connected to a correspondingly numbered PVC/PVC .75mm flexible cable. The flexible cables shall be capable of supporting the weight of the probe and cable, without the need for additional support.

C. Provide a 10-channel intrinsic barrier approved for use with the probe described above. Barrier shall isolate probe sensors for intrinsically safe installation. Model Number MTISB-10

PART 3 EXECUTION

3.1 PANELS AND PANEL MOUNTED EQUIPMENT

A. Panels and panel-mounted equipment shall be pre-assembled at the control supplier's factory. No work, other than correction of minor defects or minor transit damage, shall be done to the panels at the job site.

B. Panels shall be mounted where shown. Contractor shall anchor the panels as shown. Provide shims as required to set panels level. Conflicts with other equipment shall be brought to the attention of the Engineer for direction before taking any further action.

C. Panel Assemblies:

1. The supplier shall assume single source responsibility for each panel assembly. A panel assembly may include mounting and wiring of relays, motor starters, transformers, and disconnecting means, or other control devices as specified by customer-supplied documentation.

2. The supplier shall provide mounting and wiring of the panel assembly in a NEMA type enclosure as specified.
3. The supplier shall wire all controller inputs and outputs to terminal blocks as specified.
4. The panel assembly shall include fuse blocks as required.
5. All electrical control products within the panel assembly shall be grounded to meet equipment specifications.
6. All cables (with associated plugs, connectors, and receptacles) requiring user field installation shall be designed for use in an industrial environment.
7. Upon receipt of the purchase order, but prior to starting the manufacture of any panel assembly, the supplier shall submit drawings, as specified, of all panel assemblies for approval.
8. At the time a panel assembly is shipped, one (1) complete, reproducible copy of the panel assembly drawings shall be provided with the panel assembly.

D. All network equipment in Control Panels shall be installed as per plans, specifications, and product installation instructions. All components shall be suitable for installation in the environment where installed. All devices shall be installed as specified by the manufacturer. All devices shall be installed to be field serviceable without taking the facility out of service. Device displays shall be positioned to be easily read when viewing directly into control panels.

3.2 INSTALLATION

A. Protection During Construction: Throughout this Contract, the Contractor shall provide protection for materials and equipment against loss or damage and from the effects of the weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

B. Material and Equipment Installation: Follow manufacturer's installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturer's instructions, and these Contract Documents, follow Engineer's decision, at no additional cost to Owner. Keep copy of manufacturer's instructions on the job site available for review at all times.

C. The Contractor shall bear ultimate responsibility and shall provide for the supply, installation, adjustment, and startup of a complete, coordinated System that shall reliably perform the specified functions.

D. The Contractor shall make all final power and signal connections (hydraulic, pneumatic, and electric) to all elements provided under this section. The Contractor shall verify and certify by written notice to the Engineer, the correctness of final signal connections and the correctness of adjustment for all elements provided under this section and all elements interfaced with the System.

E. All conduits are provided and installed under Division 26 - ELECTRICAL.

F. All wiring and cables, with the exception of certain specified special control cables, are provided and installed under Division 26 - ELECTRICAL. Specific special control cables as specified in this section shall be provided and installed under this section.

G. Cleaning and Touch-up Painting: Keep premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch-up scratches, scrapes, and chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the color, consistency, and type of surface of the original finish.

3.3 ELECTRICAL POWER AND SIGNAL WIRING

A. Control and signal wiring external to the panels and all power wiring shall conform to the requirements of Division 26 – ELECTRICAL:

1. Signal Connections: Electrical signal connections to equipment shall be made on terminal blocks or by locking plug and receptacle assemblies. Jacketed flexible conduit shall be used between equipment and rigid raceway systems except that flexible cable assemblies may be used where plug and receptacle assemblies are provided, and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 2 feet, unless otherwise shown, specified, or required for specific installation locations (such as wet well sensors). Flexible cable, receptacle and plug assemblies shall be used only were shown or specified.

B. Control and signal wiring in panels shall be restrained by plastic ties or ducts:

1. Hinge wiring shall be double secured at each end with mechanically fastened, not adhesive, tie blocks or straps.
2. Hinge crossings shall be either longitudinal crossings with a minimum length of 12 inches, so that any bending or twisting will be around the longitudinal axis of the wire, or loop crossings with a minimum loop diameter of 6 inches.

3. The entire length of wire in the bend area, (between the tie blocks) shall be protected from abrasion with either convoluted tubing or spiral wrap.
4. Wire bundles that pass through holes shall be protected from abrasion with either grommets or sleeves.
5. Wires that pass across edges of sheet metal shall be protected from abrasion.

C. Arrange wiring neatly, cut to proper length, and remove surplus wire.

D. Use manufacturer's recommended tool with the proper sized anvil for all crimp terminations. No more than two wires may be terminated in a single crimp lug and no more than two lugs may be installed on a single screw terminal:

1. All crimp lugs used in applications with two wires terminated in a single crimp lug shall be rated by the manufacturer for multiple wire use.

E. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

3.4 TESTING, START-UP, AND TRAINING

A. All elements of the System shall be tested to demonstrate that the System satisfies all of the requirements of this Specification.

B. The Contractor shall provide all special testing materials and equipment.

C. The Contractor shall coordinate all of his testing with the Owner’s Representative and all other associated contractors.

D. Within 12 weeks after award of the contract, and no later than 60 days prior to the testing, the Contractor shall prepare and submit to the Engineer for review, a detailed description of the test procedures proposed to demonstrate conformance of the System to this Specification and the report forms to be used for recording the test results. The testing procedures shall be designed by the Contractor to duplicate normal operating and all alarm conditions. The Contractor shall ensure that the equipment and facilities are not damaged during testing. The decision of the Engineer upon the acceptability of the test procedures and report forms shall be final.

E. As a minimum, the testing shall include the following:

1. Factory tests: Prior to shipment, all panel assemblies shall be tested for proper operation at the manufacturer's factory. Results of the factory tests shall be recorded and submitted for approval before shipment of any panel assembly to the project site.

a. Contractor shall notify the Engineer at least one (1) week prior to the date of factory tests to allow the Engineer to witness the tests.
b. Contractor shall schedule at least one (1) full day of testing at the test facility.
c. All analog and discrete signals (inputs and outputs), power distribution equipment, pilot devices, control relays, and other devices shall be tested on a “line-by-line” basis using the schematics for reference. All analog and discrete field connections shall be simulated at the panel terminal blocks. At a minimum, analog signals shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of signal to verify device operation. Alarm and control setpoints shall also be tested as directed by the Engineer.
d. Control components that are found to be non-functional or damaged shall be replaced prior to panel assembly approval and shipment to the project site.

2. Operational Acceptance Tests:

a. The objective of these tests is to demonstrate that the System is READY for final operation.
b. The System shall be checked for proper installation, adjustment, and calibration on an “element-by-element” basis to verify that it functions as specified and that all terminations have been made correctly.
c. All discrete elements set points shall be adjusted and checked for proper operation (e.g., interlock function, contact closure on rising/falling P.V., etc.).
d. All analog loops shall have three-point calibrations performed.
e. All initial controller tuning constants shall be adjusted to preliminary settings as recommended by the manufacturer.
f. The "Operational Acceptance Tests" shall be completed prior to starting the "Functional Acceptance Test". The actual testing program shall be conducted in accordance with prior approved procedures and shall be documented.

3. Functional Acceptance Tests:

a. The objective of these tests is to demonstrate that the System operates correctly and complies with the specified performance requirements. All data points shall be tested by activating the field elements and verifying proper System response. The Contractor shall provide a minimum one (1) day Functional Acceptance Test by qualified personnel. One day of testing shall constitute eight (8) hours of on-site work. During this period, the Contractor's personnel shall operate the System under normal and all alarm conditions to simulate all operating modes of all equipment.

b. A witnessed "Functional Acceptance Test" shall be performed on the System. Each function shall be demonstrated to the satisfaction of the Engineer.

c. Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure and then tested in accordance with the Contractor's approved test procedure. Data shall be entered on the applicable test form at the time of testing. Alarm trips, control trips, and switches shall be set to initial values. Final elements shall be checked for range, dead-band, and speed of response. Any component that fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

d. Adjust tuning constants as required for proper System operation. Provide final tuning constant information in tabular form for inclusion in the Operation and Maintenance Manuals.

e. Each test shall be witnessed and signed off by the Contractor and the Owner's representative upon satisfactory completion.

f. The actual testing program shall be conducted in accordance with the prior approved procedures and shall be documented as required.

g. The Contractor shall notify the Engineer and the Owner's representative and submit the results of the "Operational Acceptance Tests," at least 1 week prior to the date of the "Functional Acceptance Test".

F. In addition to the test procedures, the Contractor shall provide a minimum of 1 day(s) of System training. The Contractor shall also provide an outline for the training to be provided that covers basic software and equipment training, operator training, System maintenance training, and programming training. Identify the course content and the time to be spent on each subject area.

END OF SECTION

SECTION 40 94 23 - FLOW PROCESS MEASUREMENT DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes flow rate measurement devices, including sensors and transmitters. Magnetic flow meter are covered in this Section.

B. Section Includes:

1. Magnetic flow meters
2. Transmitters

C. Related Requirements:

1. Section 10 14 10, Identifying Devices.
2. Section 40 05 13, Common Work Results for Process Piping.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

B. ASTM International (ASTM):

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.

C. American Water Works Association (AWWA):

1. AWWA C200 - Steel Water Pipe 6 Inch (150 mm) and Larger

2. AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4-inch Through 144-inch.

3. AWWA C704 - Propeller-Type Meters for Waterworks Applications.

4. AWWA Manual M6 - Water Meters-Selection, Installation, Testing, And Maintenance.

D. National Electrical Manufacturers Association (NEMA):

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NSF International (NSF):

1. NSF Standard 61 - Drinking Water System Components - Health Effects.
2. NSF Standard 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with pump station upgrades.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's Product Data for system materials and component equipment, including connection requirements.

C. Shop Drawings:

1. Indicate system materials and component equipment.
2. Wiring diagrams and electrical data.
3. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manual: Complete operation and maintenance instructions for metering systems, including relevant instrumentation and controls.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports:

1. Certify that equipment has been installed according to manufacturer's instructions.
2. Indicate activities on Site, adverse findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

B. Tools: Furnish special wrenches and/or other specialty devices required for Owner to maintain devices.

1.7 QUALITY ASSURANCE

A. Ensure materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF Standard 61 and NSF Standard 372.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept equipment on Site in manufacturer's original packaging and inspect for damage.

C. Store equipment according to manufacturer's instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from areas involved in construction operations.

2. Provide additional protection according to manufacturer's instructions.

1.9 CLEANUP

A. Prior to final acceptance, remove all debris from the site. Clean all meters, controls, cabinets, and other metering appurtenances.

1.10 WARRANTY

A. Furnish two-year manufacturer's warranty for flow measurement devices.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Furnish all materials, including unit conversions and algorithms, as required, for application as specified herein.

2.2 MAGNETIC FLOW METERS

A. Manufacturers:

1. Endress + Hauser, Promag W400.
2. Siemens.

B. Description: Low-frequency, electromagnetic induction-type flow meter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.

C. Flow Rate Range: 0 to 5,000 gpm

D. Size: As indicated on Drawings.

E. Flow Tubes:

1. Material: Type 304 stainless steel, with polyurethane liner.

2. End Connections:

a. Flanged, ASME B16.1, Class 125, carbon steel.
b. As specified in Section 40 05 13, Common Work Results for Process Piping.

F. Electrodes:

1. Type 316L stainless steel.
2. Self-cleaning.

G. Outputs: Isolated outputs shall be 4-20 milliampere (mA) direct current (DC) plus two digital outputs.

H. Inputs: Provide both analog and digital signals.

I. Coating: Epoxy, AWWA C550.

J. Flow Measurement:

1. Bi-directional.
2. Accuracy: Plus or minus 1 percent of actual flow rate over a 10:1 range.

3. Provide adjustment for zero and span.

K. Function as specified herein at temperatures between - 5 degrees Fahrenheit (F) and 140 degrees F and when submerged below 10 feet of water on an occasional basis.

L. Accessories:

1. Furnish cable between the transmitter and receiver.
2. Spool grounding kit and/or ground rings as required by manufacturer.

2.3 TRANSMITTERS

A. Transmitter Output:

1. 4 to 20 mA dc analog signal.
2. Accuracy: Plus or minus 1 percent of full scale.

B. Housing: NEMA 4X.

C. Human Machine Interface (HMI):

1. Touch-screen programming, functioning through enclosure window without opening enclosure.

2. Display:

a. Size: Four lines by 16 characters.
b. Type: Backlit liquid-crystal display (LCD).
c. User-selectable engineering units.
d. Readout of diagnostic error messages.

D. Mounting:

1. Remote mounting at Control Panel
2. Provide stainless-steel mounting posts.

E. Transmitter Communication Interface: HART

F. Accessories:

1. Current signal output simulation.

2. Empty pipe detection.

3. Self-diagnostics.

4. Automatic zero adjustment.

5. Stainless-steel sunshield.

6. Signal Cable: Provided by flow meter manufacturer.

    a. Cable:

        1) One-half-inch diameter, National Pipe Thread Taper (NPT) connections.

        2) Provide in a single length to meet requirements shown in Drawings. No splicing of cables will be allowed. Include cable length in Shop Drawings.

2.4 OPERATION

A. Control Power:

1. Provide with wide range power.

    a. AC100 to 240 V.
    b. AC/DC24 V.

2. Furnish local transformers as required.

B. Enclosures: IP 68 submersible (Type 6P enclosure)

1. Rated for Class 1, Division 2 space.

2.5 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of meters according to AWWA Manual M6.

B. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of flow meter with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing:

1. Test and calibrate flow meter to demonstrate that it meets specified accuracy requirements.

2. Comply with AWWA Manual M6.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section as identified in Section, 01 75 16 Testing, Training and System Start-Up.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.

2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 41 22 00 – HOISTS AND CRANES, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide a complete jib crane system that shall include all hoisting equipment, trolley, jib crane structure, mounting brackets and fasteners, and all other ancillary appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of this Section apply to all hoists and cranes unless indicated otherwise.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. American Institute of Steel Construction

1. Specifications for the Design, Fabrication, and Erection of Structural Steel for Building

B. American national Standards Institute (ANSI)

1. ANSI HST-1M – Performance Standard for Electric Chain Hoists

2. ANSI B30.2 – Safety Standard-Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Hoist)

3. ANSI B30.10 – Hooks

4. ANSI B30.11 – Monorails and Underhung Cranes

5. ANSI B30.16 – Overhead Hoists (Underhung)

C. American Society for Testing and Materials (ASTM)

1. ASTM A36 – Carbon Structural Steel

D. Occupational Safety and Health Administration (OSHA)

1. OSHA 1910.179 of Title 29 – Occupational Safety and Health Regulations-Overhead and Gantry Cranes

E. National Electrical Manufacturers Association (NEMA)

F. National Fire Protection Association (NFPA)

1. NFPA 70 – National Electric Code

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 30 00 – Submittal Procedures.

B. Shop Drawings shall include electrical requirements, weights, wheel loads, dimensions, and clearances required.

C. Technical Manuals: Include complete operating and maintenance instructions of the hoist and crane systems.

1.4 QUALITY ASSURANCE

A. Inspection and Testing Requirements: After installation, the Contractor shall inspect and test hoists and crane systems in the presence of the manufacturer's service representative, for proper operation and conformance to the Specifications.

B. Acceptance Criteria and Tolerances: The Owner's Representative reserves the right to reject any equipment not conforming to the tolerances, deflections, and lateral stiffness indicated.

1.5 MANUFACTURER'S SERVICES

A. The Contractor shall arrange for the hoist or crane manufacturer to furnish the services of a trained, qualified representative for at least one day after the units are installed, for the purpose of inspecting the installation and instructing the Owner's operating personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment of similar design shall be from a single manufacturer.

B. The capacity of each hoist and trolley shall be permanently marked in a conspicuous manner on the equipment.

C. Hooks shall be safety type with latch.

D. The Contractor shall verify dimensions and clearances in the field prior to installation and shall be responsible for the proper fitting and operation of the equipment.

2.2 JIB CRANE

A. Design Features

1. General – Jib Crane shall be a free-standing jib crane with 360-degree range of motion.

2. Dimensions:

   a. Height Under Beam (HUB) – 16’-0”
   b. Span – 16’-0”

3. Material:

   a. Steel conforming to ASTM A6
   b. Span shall be constructed of 20-W18 steel

4. Jib crane to be outdoor rated and designed to operate in a maximum of 15 mph winds.

5. Jib crane shall have independent head assembly with a head retaining pin.

6. Crane motor to be fully enclosed and protected from weather.

7. Jib crane shall be designed to withstand a minimum capacity of 2 tons at full extension.

8. Base plate to be at minimum 1 ¼” thick with 12 anchor bolt holes.

9. Motor:

   a. 1HP 460V 3-phase totally enclosed fan cooled motor.
   b. Marathon Motors model No. 056T17F15639 or approved equal.

10. Warranty:

    a. Minimum 10-year manufacturer warranty.

11. Manufacturer:

    a. Gorbel, model FS300DD or;
    b. Approved equal.

2.3 HOIST AND TROLLEY:

A. 2-ton capacity hoist with minimum 55-foot Lift length.

B. Hoist to be of steel construction.

C. Control Pendant to be NEMA-4 rated with a minimum chord length of 36 feet.

D. Speed:

1. Lifting speed to be a maximum 14 fpm and be adjustable via VFD.
2. Transversing Speed to be a maximum 40 fpm and be adjustable via VFD

E. Motor:

1. 460V-3ph-60HZ Power Supply.
2. Outdoor rated.

F. Manufacturer:

1. Harrington Model No. NERM or;
2. Approved equal.

2.4 PLANT FABRICATED ITEMS

A. Fabrication, assembly, and welding shall be carried out by factory-trained specialists and certified welders.

2.5 TOOLS AND SPARE PARTS

A. Tools: The Contractor shall furnish one complete set of special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of the best quality and furnished in labeled toolboxes of suitable design.

B. Spare Parts: Furnish spare parts as required by the hoist or crane section. Parts shall be properly labeled and identified with the name and number of the equipment to which they belong.

PART 3 EXECUTION

3.1 INSTALLATION

A. Hoist and crane equipment shall be installed in strict accordance with the manufacturer's printed instructions.

B. Workmanship shall be in accordance with the referenced standards and codes.

C. Care shall be taken that the structural integrity of beams, columns, walls, floors, and roofs will be maintained at all times.

3.2 FIELD TESTING

A. After completion of the work, the Contractor shall test hoist and crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets applicable standards and specifications.

B. During pump station startup, a lifting test shall be completed to verify that the crane and hoist system can lift each of the installed pumps, with the Engineer present.

END OF SECTION

SECTION 43 21 00 - LIQUID PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated.

B. Where two or more pump systems of the same type or size are required, all pumps shall all be produced by the same manufacturer.

C. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps selected by the OWNER.

D. Coordinate and utilize all factory testing, installation, start-up and field testing services supplied in conjunction with the pumping equipment.

E. All work performed under this Section shall be in accordance with all approved trade practices and manufacturer's recommendations.

F. Section includes:

1. General design requirements for liquid pumps.
2. Factory testing.

G. Related Requirements:

1. Section 43 21 39 - Submersible Liquid Pumps.

1.2 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Provide the following information:

1. Pump name, identification number and applicable Section number from Project specifications.

2. Performance Data Curves:

a. Showing head, capacity, horsepower demand, NPSH required and pump efficiency over the entire operating range of the pump.

b. Pump manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.

c. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each pump equipped with a variable speed drive.

3. The limits on the performance curves recommended for stable operation without surge, cavitation or excessive vibration.

4. Assembly and Installation Drawings: Including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

C. Complete motor nameplate data as defined by NEMA, motor manufacturer and any motor modifications.

D. Operation and Maintenance Manual: Containing the required information for each pump section.

E. Spare Parts List: Containing the required information for each pump section.

F. Factory Test Data: Signed, dated and certified for each pump system which requires factory testing submitted before shipment of equipment.

G. Certifications:

1. Manufacturer's certification of proper installation.
2. CONTRACTOR's certification of satisfactory field testing.

H. All pump motor information as required in Division 43.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be standard products of a manufacturer and distributor regularly engaged in the manufacture and distribution of such products for at least 2 (two) years and shall be suitable for the service intended.

B. All materials and equipment shall be new and unused except for the testing specified herein.

C. Compliance with the requirements of the individual pump sections may necessitate modifications to the manufacturer's standard equipment.

D. All components of each pump system provided under the pump sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings and appurtenances.

E. The pumps shall be supplied by a distributor authorized to service them throughout the warranty period and beyond. The distributor shall be located within a 100-mile radius of the site.

F. The pumps shall be warranted by the manufacturer as specified in other Sections.

G. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors, suction cans, baseplates, couplings, guards and other accessories.

H. The complete pump assembly shall be designed and built for continuous service at any and all points within the specified range of operation, without overheating, without damaging cavitation, and without excessive vibration or noise.

2.2 MATERIALS

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Casings, Class 30, or equal.

2. Stainless steel pump shafts shall be Type 416 or 316.

3. Miscellaneous stainless steel shall be of Type 316, except in a septic environment.

4. Anchor bolts, washers, and nuts supplied by the CONTRACTOR for non-corrosive applications shall be galvanized steel in accordance with the requirements of Section 05 50 00, Metal Fabrications. Anchor bolts, washers and nuts in corrosive service applications shall be stainless steel in accordance with that Section.

2.3 PUMP COMPONENTS, GENERAL

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 12, 125, 250, and 800 or B16.5 - Flanges and Flanged Fittings dimensions.

B. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed and manufacturer's name and model number.

2.5 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system:

1. Pump Systems: All pump systems 50 hp and larger shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute.

2. Tests shall be performed using the complete pump system to be furnished, including the motor.

3. For motors 100 hp and smaller , the manufacturer's certified test motor shall be acceptable. The following minimum test data shall be submitted:

    a. Hydrostatic test data.

    b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.

    c. Pump curves showing head, flow, bhp, and efficiency.

    d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

    e. Pump test data curves showing head, flowrate, bhp, and efficiency. Acceptance level shall be Grade 1E as defined by ANSI/HI 14.6.

4. Factory Witnessed Tests: Factory witnessed testing for this project not required.

5. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR and Pump Manufacturer shall make all necessary modifications, repairs or replacements to conform to the requirements of the Contract Documents and the pump shall be retested at no additional cost to the OWNER until found satisfactory.

PART 3 EXECUTION

3.1 SERVICES OF PUMP MANUFACTURER

A. An authorized service representative of the manufacturer shall visit the Site to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted and readied for operation:

1. Installation of the equipment.

2. Inspection, checking and adjusting the equipment.

3. Startup and field testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

5. Requirements are more specifically detailed herein and in individual pump specifications.

B. Instruction of the OWNER's Personnel:

1. An authorized training representative of the manufacturer shall visit the Site to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

2. Instruction shall be specific to the models of equipment provided.

3. The pump manufacturer's representative shall have at least two years' experience in training.

4. Training shall be scheduled a minimum of three weeks in advance of the first session.

5. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

6. The training materials shall remain with the trainees.

7. The OWNER may videotape the training for later use with the OWNER's personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment:

1. All equipment shall be field tested to verify proper alignment, operation as specified and freedom from binding, scraping, vibration, shaft runout or other defects.

2. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing.

3. Equipment shall be secure in position and neat in appearance.

C. Lubricants: Provide the necessary oil and grease for initial operation.

3.3 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or overheating of bearings.

B. Field testing methods and allowable tolerances shall comply with current version of the Hydraulics Institute standards for the type of pumps installed.

C. The following field testing shall be conducted:

1. Startup, check and operate the pump system over its entire speed range.

2. Obtain concurrent readings of motor voltage, amperage, pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.

D. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

E. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

F. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests and the test data.

G. CONTRACTOR shall bear all costs of field tests, including additional services of the manufacturer's representative required beyond those specified.

END OF SECTION

SECTION 43 21 39 - SUBMERSIBLE LIQUID PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes furnishing, start-up, testing, and operation training for submersible sewage pumps.

B. Section includes:

1. Submersible sewage sump pumps.

C. Related Sections

1. Section 01 75 16, Testing, Training & System Start-Up.
2. Section 10 14 10, Identifying Devices.
3. Section 40 05 13, Common Work Results for Process Piping.
4. Section 43 21 00, Liquid Pumps.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

B. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Per the requirements of Section 43 21 00, Liquid Pumps.
B. Applicable material certifications and testing certificates.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

B. Pump Supplier: Manufacturer’s installation and operation certificate. Statement that the equipment is suitable for the intended use.

1.5 FACTORY TESTING

A. Pump manufacturer shall provide the following factory tests in accordance with Section 43 21 00, Liquid Pumps:

1. Performance test.
2. Hydrostatic test.
3. Submersible motor integrity test.
4. Vibration test.

1.6 COORDINATION

A. Like items of equipment specified herein shall be the end product of one manufacturer.

B. Electrical controls and motor design requirements are specified in this Section and Division 26, Electrical.

C. Coordinate pump requirements with the pump drive manufacturer. Contractor shall be responsible for the overall pump and drive performance.

1.7 WARRANTY

A. Submersible sewage pumps shall be warranted by the manufacturer for a minimum of five (5) years and shall meet or exceed the following warranty requirements:

1. Full warranty for the first 2 years.
2. Limited 50% warranty for any claim during years 3 and 4.
3. Limited 25% warranty for any claim during the 5th year.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Manufacturers:

1. Xylem, Flygt, Model NP 3231/675 with MAS 801 monitoring and status unit.
2. Approved equal.

B. Identification:

Location	Woodburn I-5 Pump Station
Pump Label(s)	P-1, P-2
Quantity	2

C. Power and Motor Requirements:

Voltage	480
Phase	3
Frequency	60 Hz
Motor Speed	1,185 rpm
Motor Horsepower	140 hp

D. Performance Requirements at Full Pump Speed, Two Pumps Running

Duty Point 1 Minimum Flow Capacity	2,900 gpm
Duty Point 1 Total Dynamic Head	130 feet
Duty Point 1 Minimum Pump Efficiency	82%
Maximum NPSH required at Duty Point 1	15 feet

E. Operating Conditions:

Duty	Continuous
Drive	Variable Frequency Drive
Ambient Environment	Wet Well - Corrosive
Ambient Temperature	33° - 104° F
Fluid Service	Municipal wastewater, raw and unscreened, containing rags, grit, fats, oil, and debris.
Minimum Solids Passing Capability	Flygt N-Impeller
Fluid Temperature	50° - 90° F
Fluid pH Range	6.0 to 8.0
Fluid Specific Gravity	1.0
Net Positive Suction Head Available at Duty Point 1	35 feet

F. Pumping System Dimensions:

Minimum Pump Discharge Size	7 7/8-inch
Base Elbow Discharge Size	7 7/8-inch
Discharge Flange Rating (ANSI)	Class 125
Minimum Submersible Cable Length	As Required

2.2 PUMP CONSTRUCTION

A. Pump, General:

1. Heavy-duty, vertical, submersible pump with integral drive motor, single suction, centrifugal, sewage type, suitable for a permanent-type wet well installation.

2. Major pump components shall be of gray cast iron, ASTM A48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities.

3. All exposed nuts or bolts shall be AISI type 304 stainless steel.

4. All metal surfaces in contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

B. Impeller:

1. ASTM A-532 (Alloy III A), 25% chrome cast iron, dynamically balanced, semi-open, multi-vane, back-swept, non-clog design.

2. Vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across spiral grooves located on the volute suction, which shall keep them clear of debris, maintaining an unobstructed impeller leading edge and sustaining a high level of hydraulic efficiency.

3. Screw-shaped leading edges of the hard-iron impeller shall be hardened to 60 HRC and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in raw wastewater.

4. Screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater.

5. Impeller shall be locked to the shaft, held by an impeller bolt and treated with a corrosion inhibitor.

C. Volute:

1. 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.

2. Minimum inlet and discharge size shall be as specified.

3. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s).

4. 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.

5. The insert ring shall be cast of ASTM A-532 (Alloy III A), 25% chrome cast iron and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

D. Shaft:

1. Pump and motor shaft shall be a solid continuous shaft.

2. The pump shaft shall be an extension of the motor shaft.

3. Couplings will not be acceptable.

4. The pump shaft shall be stainless steel ASTM A479 S43100-T.

5. The shaft shall be adequately designed to endure alternating bending stresses and to provide for minimum overhang to reduce shaft deflection and prolong bearing life.

E. Bearings:

1. The pump shaft shall rotate on at least three grease-lubricated bearings.

2. The upper bearing, provided for radial forces, shall be a single roller bearing.

3. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.

4. The minimum L10 bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.

5. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature.

F. Mechanical Seal:

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies.

2. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate.

3. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring.

4. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system.

5. The seals shall not require maintenance or adjustment and shall be capable of operating in either clockwise or counter-clockwise direction of rotation without damage or loss of seal. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm.

6. Any intrusion of fluid shall not come into contact with the lower bearings.

7. Conventional double mechanical seals with a single or a double spring between rotating faces, or that require constant differential pressure to affect sealing and are subject to opening and penetration by pumping forces, will not be acceptable.

8. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti leak seal, shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication.

9. The motor shall be able to operate continuously while not submerged without damage while pumping under load. Seal lubricant shall be FDA approved.

G. Cooling System:

1. Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A 48, Class 35B. The water jacket shall provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air.

2. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the filtered pump media, through the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket.

3. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided.

4. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and seal flushing or air relief are to be provided.

5. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4-inch diameter located 180 degrees apart.

6. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.

H. Pump Discharge Elbow:

1. The pump discharge connection shall be the elbow type.

2. The discharge connection shall be bolted to the structure as recommended by the manufacturer and shall serve as a lower attachment for the guide rails, and as anchorage for the pump.

3. The anchorage system shall be designed to transmit all forces safely to the structure, and may incorporate intermediate supports as required.

4. The design shall be non-sparking and shall conform to UL requirements for installation in a Class 1, Division 1, Group D hazardous location.

5. When in place, the discharge connection shall cause a watertight seal between the pump and the discharge elbow, accomplished by a machined metal to metal contact only, using simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressing tightly against the discharge connections.

6. Sealing of the discharge interface with a diaphragm, O-ring, or profile gasket shall not be acceptable. No portion of the pump shall bear directly on the floor of the wet well and no rotary motion of the pump shall be required for sealing.

I. Dual Rail Guide System

1. The pump shall be provided with a dual rail guide system to automatically and firmly connect the pump to the discharge piping when lowered into place on the discharge elbow.

2. Once the pump has been positioned on its support fitting at the discharge elbow, the guide rail system shall not be required for pump support. Intermediate support brackets shall be provided as required by manufacturer.

3. The guide rail system shall allow easy removal of the pump without entering the wet well or disturbing the discharge piping. Single rail systems are not acceptable.

4. All components of the guide system and pump anchorage shall be of stainless steel.

J. Lifting Devices:

1. Each pump shall be provided with Flygt Pump Lift Lifting System.

2. Provide minimum of 25 feet of stainless steel cable connected to a short length (approximately ten links long) of high tensile strength proof-tested stainless steel chain of required capacity, connected to the lifting eye or lifting bail of the submersible pump.

3. Provide a forged "grip-eye" of stainless steel, provided separately to connect to the end of the lifting cable or chain of the pump lifting device.

4. All lifting devices shall be rated as lifting devices and shall be provided with certification indicating they are rated for lifting device service.

2.3 MOTORS

A. General:

1. Each pump shall be provided with a vertically mounted electric motor that conforms to the following requirements:

a. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump.

b. The motor and the pump shall be produced by the same manufacturer.

c. The motor shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

B. Motor Design:

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.

2. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%.

3. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.

4. The stator shall be heat-shrink fitted into the cast iron stator housing.

5. The use of multiple step dip and bake-type stator insulation process is not acceptable.

6. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.

7. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 15 evenly spaced starts per hour.

8. The rotor bars and short circuit rings shall be made of cast aluminum.

C. Service Factors:

1. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15.

2. The motor shall have a voltage tolerance of plus or minus 10%.

3. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C.

4. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no load characteristics.

D. Moisture Protection:

1. A mechanical float switch (FLS) shall be mounted in the junction chamber to signal if there is water intrusion.

E. Memory Module:

1. A pump memory module shall be provided and mounted in the junction chamber to record pump run time, number of starts as well as contain the motor unit performance and manufacturing data and service history.

2. The use of wire nuts or crimp-type connectors is not acceptable.

F. High Temperature Protection:

1. Thermal switches shall be embedded in the stator end coils to monitor the temperature of each phase winding.

2. One PT-100 type temperature sensor shall be installed in the stator winding.

3. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.

4. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals.

G. Power Cable:

1. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices.

2. The power cable shall be of a shielded design in which an overall tinned copper shield is included and each individual phase conductor is shielded with an aluminum coated foil wrap.

3. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber.

4. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

H. Pilot Cable:

1. The pilot cable for connection to the pump protection sensors shall be shielded, twisted pair cable integral with the power cable.

I. Cable Entry Seal:

1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal.

2. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function.

3. The assembly shall provide ease of changing the cable when necessary using the same entry seal.

4. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.

5. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.4 PROTECTION

A. All stators shall incorporate three bi-metal thermal switches, one for each stator phase winding, connected in series to monitor temperature of the motor winding. Should high temperature occur, the thermal switches shall open, stop the motor and activate an alarm. The stator shall also include one PT-100 type temperature probe to provide for monitoring of the stator temperature.

B. A lower bearing temperature sensor shall be provided. The sensor shall directly contact the outer race of the thrust bearing providing for accurate temperature monitoring.

C. Two leakage sensors shall be provided to detect water intrusion into the stator chamber and junction chamber. A Float Leakage Sensor (FLS), a small float switch, shall be used to detect the presence of water in either the stator chamber or junction chamber. When activated, the FLS will activate an alarm.

D. The solid-state pump memory unit, three thermal switches, two FLS switches, PT-100 stator temperature monitor and the lower bearing PT-100 temperature monitor shall all be connected to a MAS 801 (Monitoring and Status) monitoring unit. The MAS shall be designed to be mounted in the control panel and shall come with an Operator Panel that is dead-front panel mounted. The Operator Panel shall have soft-touch operator keys and provide local indication of the status of the alarms within the connected pump unit by means of an LCD screen read-out. Local MAS system change shall be made by use of the soft-touch keypad or local connection by means of a laptop computer.

2.5 OTHER REQUIREMENTS

A. The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading at a minimum flow rate equal to 130-percent of Duty Point 1 without employing the service factor.

B. The entire pump assembly shall be U.L. approved as Explosion Proof for operation in a Class 1, Division 1, Group D hazardous location.

PART 3 EXECUTION

3.1 INSPECTION

Inspect pumps and fittings before installation to verify quality of material.

3.2 INSTALLATION

A. Installation:

1. Install and align pumps and fittings in accordance with the manufacturer's printed specifications and at the locations shown on the Drawings.

2. Use anchor bolts furnished or recommended by the manufacturer.

3. Place the pumps using equipment templates.

B. Anchorage:

1. Anchors for the unit shall be set in the concrete. Unit shall be mounted as instructed by the manufacturer.

2. Anchors shall be drilled and set with epoxy.

3. Provide 24 hours' notice prior to installing base elbows, to allow for anchor bolt inspection.

4. The manufacturer shall supervise installation to ensure that the unit is properly aligned and leveled; that all electrical and piping connections are properly made; and that lubricants have been provided and installed.

3.3 STARTUP AND TESTING

A. See Section 01 75 16, Testing, Training & System Start-Up for additional requirements.

B. Pre-operational Checks:

1. Check pump and motor alignment.
2. Check for proper motor rotation.
3. Check pump and drive units for proper lubrication.

C. Manufacturer's Representative:

1. Furnish a representative of the manufacturer to perform inspection, start-up and training services.

2. The manufacturer's representative shall be experienced in the operation and maintenance of the equipment and shall instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

3. Check pump and motor for high bearing temperature and excessive vibration.

4. The representative shall check the installation and supervise initial start-up of the equipment, and shall perform, at a minimum, the following tests on each pump:

    a. Measure and record shutoff head and power draw at shutoff head.

    b. Measure and record actual operating head and power draw at actual operating head.

    c. Measure and record operating head and power draw at two separate partially throttled flow rates.

    d. Measure and record static head.

    e. Duplicate all normal operating modes and all failure modes, including the removal and installation of pumps from the wet well using the guide rail system.

5. Testing shall include a comparison of measured installed flow and head, including shutoff head, with the manufacturer's curve value. Any discrepancy shall be resolved prior to acceptance by the Owner.

6. Manufacturer's Written Certification:

    a. The manufacturer's representative shall verify the complete assembly for proper alignment and connection, and quiet operation.

    b. This service shall be provided for a minimum period of one trip and one day.

    c. After the installation and operation of the equipment has been certified, the manufacturer's representative shall train the Owner's personnel in the proper operation and maintenance of the equipment.

D. Verify pumps are operating at the design duty condition. Remove and replace units that do not meet the design operating criteria.

E. For all pump tests, ensure that the force main is full of liquid during the testing. The Contractor shall provide the necessary water and other materials required for the testing as defined herein and recommended by the manufacturer. All testing shall use clean water as required by Section 01 75 16, Testing, Training & System Start-Up.

F. Submersible Pump Lift Test:

1. Lift each submersible pump above the access hatch and then lower the pump back down onto the discharge elbow to demonstrate adequate clearances, smooth operation of the guide rail system, and proper re-seating of the pump on the discharge elbow.

G. A start-up report, acceptable to and approved by the Engineer, shall be completed by the manufacturer's representative before final acceptance of the pumps.

END OF SECTION