MoDOT

SEWER IMPROVEMENTS

KING CITY, MISSOURI

OCTOBER 2014

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TECHNICAL SPECIFICATIONS

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END OF DOCUMENT

DOCUMENT 00005
CERTIFICATIONS PAGE

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.

Signature: Philip Ryan Wilson Date: 10/20/14

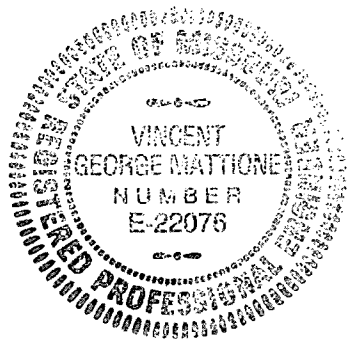
Name: Philip Ryan Wilson

Missouri License No.: PE-2008019618

My license renewal date is December 31, 2014.

Pages, Sheets, or Divisions covered by this seal: Division 01, Division 02, Division 03, and Division 11

DOCUMENT 00005
CERTIFICATIONS PAGE



I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.

Signature: /s/ Vincent Mattione Date: 10/23/14

Name: Vincent George Mattione

Missouri License No.: 022076

My license renewal date is December 31, 2016.

Pages, Sheets, or Divisions covered by this seal: Division 16.

END OF DOCUMENT 00005

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract Description.

B. Work by Owner.

C. Cash Allowances

D. Salvage of Materials and Equipment

E. Contractor use of site and premises.

F. Work Sequence.

G. Owner occupancy.

H. Lines and Grades.

I. Connections to Existing Facilities.

J. Cutting and Patching.

K. Products Assigned to Contractor

1.2 CONTRACT DESCRIPTION

A. Contract Type: Lump Sum, as set forth in the Bid Form and Agreement

B. Description of Work under this Contract: Construction of the King city Maintenance Facility pump station will generally include the following:

1. The project consists of the construction of approximately 2,635 lineal feet of two-inch (2”) forcemain, one duplex pump station, 60 feet of six-inch (6”) PVC gravity sewer service line, and all the necessary appurtenances to make a complete and usable pressure sewer service connection. The project also consists of construction of approximately 150 feet of two-inch (2”) PVC water service line, 20 feet of two-inch (2”) copper water service line, meter and double check valve in meter vault, water line tap, and all the necessary appurtenances to make a complete and usable water service connection.

C. Objective of contract: It is the objective of this contract to provide the Owner with a complete and fully functional wastewater system and drinking water service. The facilities furnished and the construction performed must conform to this objective. These specifications and drawings present those minimum standards considered essential. In no respect are these requirements intended to alleviate the Contractor’s responsibility in achieving this objective.

D. Workmanship and materials: All work or materials commonly known to be required by best modern practice for any or all portions of the project shall be included in the Contractor's obligation whether or not shown on drawings or called for in these specifications.

1.3 WORK BY OWNER

A. The Owner will not be performing any work on this project.

B. Items noted NIC (Not in Contract), such as movable furnishings and minor equipment, will be supplied or relocated, and installed by Owner after Substantial Completion.

1.4 CASH ALLOWANCES

A. Testing Allowance: No testing allowance used. Testing to be paid by Contractor.

1.5 SALVAGE OF MATERIALS AND EQUIPMENT

A. Existing materials and equipment removed and not reused or retained by Owner shall be disposed of by Contractor. Owner will notify Contractor of construction project items which Owner desires to retain.

1.6 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow:
   1. Owner occupancy, operations, and maintenance.
   2. Work by Owner.

B. Construction Operations:
   1. Limited to areas within general limits shown on the Drawings, inside Owners properties and, easements, except where specifically noted on the Drawings.
   2. Contractor may use the areas noted on the Drawings for storage and staging.

C. Time Restrictions: No work shall be done on Sunday, legal holidays, or at night, without the approval of Owner in each case, except such work as may be necessary for the proper care, maintenance and protection of work already done or of equipment and public property covered by the Contract, or to meet demanding time limitations on specific work activities called for under this contract. Approval of Owner shall be sought at least forty-eight (48) hours in advance of such work whenever practicable.
   1. Before Contractor requests work to take place on Sundays, or legal holidays on a repeated basis to expedite the Work or make up for lost progress, Contractor shall first schedule and work five weekdays and Saturdays for at least two weeks prior.

D. Unfavorable Construction Conditions: During unfavorable weather, wet ground, or other unsuitable construction conditions, Contractor shall confine his operations to Work which will not be affected adversely by such conditions. No portion of the Work shall be constructed under conditions which would affect adversely the quality or efficiency thereof, unless special means or precautions are taken by Contractor to perform the Work in a proper and satisfactory manner.

E. Utility Outages and Shutdown: Brief shutdown of utilities, other than described herein, will be acceptable to Owner provided that the duration does not exceed one-half hour, and at least 48 hours prior notice has been given by Contractor.

1.7 OWNER OCCUPANCY

A. The Owner will periodically require access to the facility during the entire period of construction. To the extent possible, Owner's personnel will restrict activities to not interfere with construction.

B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

1.8 CONNECTIONS TO EXISTING FACILITIES

A. Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities, including structures, drain lines, and utilities such as water, sewer, telephone, and electric. In each case, Contractor shall receive permission from Owner or the owning utility prior to undertaking connections. Contractor shall protect facilities against deleterious substances and damage.

B. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Overtime work shall be scheduled with and approved by Owner in advance, as required within.

C. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

1.9 CUTTING AND PATCHING

A. Contractor shall perform all cutting and patching required for the Work and as may be necessary in connection with uncovering Work for inspection or for the correction of defective Work.

B. Contractor shall perform all cutting and patching required for and in connection with the Work, including but not limited to the following:
1. Removal of improperly timed Work.
2. Removal of samples of installed materials for testing.
3. Alteration of existing facilities.
4. Installation of new Work in existing facilities.

C. Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all Work and existing facilities during cutting and patching operations. Contractor shall not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without Engineer's concurrence.

D. Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the Work. Materials shall be removed in a careful manner, with no damage to adjacent facilities or materials. Materials which are not salvageable shall be removed from the site by Contractor.

E. All Work and existing facilities affected by cutting operations shall be restored with new materials, or with salvaged materials acceptable to Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be patched and refinished.

F. Restoration of pavement and other surface construction shall be performed in accordance with the applicable specification section.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01019

CONTRACT CONSIDERATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Schedule of values.

B. Application for payment.

C. Change procedures.

D. Defect Assessment.

1.2 RELATED SECTIONS

A. Section 01600 - Material and Equipment: Product substitutions and options.

1.3 SCHEDULE OF VALUES

A. Submit a printed schedule on Contractor's standard form or electronic media printout will be considered.

B. Submit Schedule of Values in duplicate within 10 days after date of Owner-Contractor Agreement.

C. Schedule of values shall represent a fair, reasonable, and equitable dollar cost allocation for each major work activity on Contractor's construction schedule. Schedule of values shall not be imbalanced. Engineer may declare a work task imbalanced and require Contractor to adjust values if the scheduled value differs significantly from an industry standard value or commonly accepted unit price guide.
   1. The work activities shall be subdivided in sufficient detail to serve as the basis for progress payments during construction.
      a. Items of equipment shall be itemized to divide bare equipment shipped to site, installation, and start-up services.
   2. With the exception of major equipment items, no single work activity or unit in the schedule of values shall be assigned a cost greater than ten thousand dollars ($10,000.00).

D. Revise schedule to list approved Change Orders, and resubmit with each Application for Payment.

E. Schedule of Values may serve as basis for estimating credits to Work for items deleted or reduced, or for pricing of items added to the Contract of a similar nature.

1.4 CONSTRUCTION AND PAYMENT SCHEDULES

A. The Owner desires to have this contract complete and capable of full operation within the time specified in the bid. In preparing his bid, the Contractor should anticipate this schedule. The construction sequence shall be at the option of the Contractor so long as it meets the conditions specified herein and the Owner’s approval. The Contractor shall submit to the Owner, within ten days after the execution of the Contract or no later than the time of the preconstruction conference, an estimated progress schedule indicating the starting and completion dates of the various stages of

the work and a monthly schedule of estimated payments. The schedule of estimated payments must be updated at any time there is a variation of more than 10 percent.

1.5 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of the various sections of the Specifications to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

F. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.6 CHANGE PROCEDURES

A. Changes in the Work shall be implemented according to Section 00100 BIDDER REQUIREMENTS.

1.7 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, the Engineer will direct an appropriate remedy or adjust payment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal Procedures.

B. Construction Progress Schedules.

C. Proposed Products List.

D. Submittal of Shop Drawings and Data.

E. Resubmittal of Shop Drawings and Data

F. Product Data.

G. Shop Drawings.

H. Certificates.

I. Manufacturer's Instructions.

1.2 SUBMITTAL PROCEDURES

A. Transmit each submittal with submittal form acceptable to Owner.

B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix. For example, the first submittal under Section 15100 would be numbered "15100-01", and a re-submittal of the same item(s) would be numbered "15100-01a".

C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate.

D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents. If Contractor affixes a stamp to the submittal which says "exceptions noted" or a clause to similar effect, Contractor shall specifically list all exceptions.

E. Submittal Checklist: Where specification sections list specific items to be included in the submittal, manufacturer or supplier shall make a copy of the list and include it as a checklist. Each item shall be checked that it is included. If an item is not included, an explanation as to why it was not included must be attached. If items are not included and/or an explanation why that item is not included is not attached, Engineer will return the submittal without review marked as "Revise and Resubmit". If no checklist is present, the submittal will not be reviewed until a manufacturer or supplier generated checklist is received.

F. Schedule submittals to expedite the Project, and deliver to Engineer at business address. Coordinate submission of related items.

G. Submittal Review Period by Engineer: For each submittal for review, allow fifteen (15) days excluding delivery time to and from Contractor, provided submittals are complete.

H. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.

I. Provide space for Contractor and Engineer review stamps.

J. Conform with specific submittal requirements given in the individual sections of the specifications.

K. When revised for re-submission, identify all changes made since previous submission.

L. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

M. Submittals not requested will not be recognized or processed.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial schedule in duplicate within fifteen (15) days after date established in Notice to Proceed.

B. Revise and resubmit on a monthly basis with the application for payment.

C. Submit a horizontal bar chart with separate line for each major portion of Work or operation, identifying first work day of each week.

D. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

E. Indicate estimated percentage of completion for each item of Work at each submission.

F. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by Owner and required by Allowances.

1.4 PROPOSED PRODUCTS LIST

A. Within fifteen (15) days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.5 SUBMITTAL OF SHOP DRAWINGS AND DATA

A. Submittals of shop drawings and data pertaining to equipment, materials, and products to be incorporated into the work shall be submitted to Engineer well before such equipment, materials, and products are incorporated into the Work. Payment will not be made for equipment, materials, and products delivered to the site or incorporated into the Work until submittals pertaining to such are acceptable to Engineer.

B. Engineer's review of shop drawings and data is for the limited purpose of checking for general conformity with the design concept expressed in the Contract Documents. Engineer's review does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment,

device or item shown. Engineer's review shall not relieve Contractor of Contractor's responsibility for errors, omissions, or deviations in the drawings and data, nor of the sole responsibility for compliance with the Contract Documents.

C. It shall be Contractor's responsibility to see that submittals which require revisions or re-submission receive such in a timely manner.

1.6 RESUBMITTAL OF SHOP DRAWINGS AND DATA

A. Contractor shall accept full responsibility for the completeness of each re-submittal. Contractor shall verify that all corrected data and additional information previously requested by Engineer are provided in the re-submittal.

B. Requirements specified for initial submittals shall also apply to re-submittals. Re-submittals shall bear an identification number as specified herein.

C. When corrected copies are re-submitted, Contractor shall in writing direct specific attention to all revisions and shall list separately any revisions made other than those called for by Engineer on previous submissions.

D. If more than one re-submission is required because of failure of Contractor or supplier to provide all previously requested corrected data or additional information, Contractor shall reimburse Owner for the charges of Engineer for review of the additional re-submissions. This does not include initial submittal data such as shop tests and field tests which are submitted after initial submittal, or additional information requested by Engineer that is not an item required by the project manual.

E. Re-submittals shall be made within 40 days of the date of the transmittal returning the material to be modified or corrected, unless within 30 days Contractor submits a written request for an extension of the stipulated time period, listing the reasons the re-submittal cannot be completed within that time.

F. Any need for more than one re-submission, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Times unless delay of the Work is directly caused by a change in the Work authorized by a Change Order or by failure of the Engineer to review any submittal within the submittal review period specified herein and to return the submittal to Contractor.

1.7 PRODUCT DATA

A. Product Data for Review:
   1. Submitted to Engineer for review.
   2. After review, provide copies and distribute in accordance with submittal procedures article above and for record documents purposes described in Section 01700 - Contract Closeout.

B. Product Data for Information:
   1. Submitted for Engineer's knowledge or for Owner.

C. Product Data for Project Close-out:
   1. Submitted for Owner's benefit during and after project completion.

D. Submit the number of copies which Contractor requires, plus three (3) copies which will be retained by Engineer.
   1. In lieu of hardcopy submittals, Contractor may submit to Engineer electronically in Adobe PDF format. Submittals will be reviewed and returned to Contractor electronically in Adobe PDF format.

E. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

F. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

G. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01700 - Contract Closeout.

1.8 SHOP DRAWINGS

A. Shop Drawings for Review:
   1. Submitted to Engineer for review.
   2. After review, produce copies and distribute in accordance with submittal procedures article above and for record documents purposes described in Section 01700 - Contract Closeout.

B. Shop Drawings for Information:
   1. Submitted for Engineer's knowledge as contract administrator or for Owner.

C. Shop Drawings for Project Close-out:
   1. Submitted for Owner's benefit during and after project completion.

D. Submit the number of opaque reproductions which Contractor requires, plus three (3) copies which will be retained by Engineer.

E. Upon agreement of both Owner and Engineer, Contractor may submit shop drawings electronically in Adobe Acrobat (.pdf) format in lieu of hard copies as specified in Paragraph D above.

1.9 CERTIFICATES

A. When specified in individual specification sections, submit certification by the manufacturer, installation/application subcontractor, or Contractor to Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

1.10 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer, as specified in Section 01700 - Contract Closeout.

B. Manufacturer's instructions (Operation and Maintenance Data) shall be submitted in timely manner as set forth in Section 01700 - Contract Closeout.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

D. Submit the number of copies set forth in Section 01700 - Contract Closeout.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality Assurance - Control of Installation.

B. References and Standards.

C. Testing Services.

D. Resident Observation.

E. Offsite Inspection.

F. Examination.

G. Preparation.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work.

B. Section 01300 - Submittals: Submission of manufacturers' instructions and certificates.

1.3 QUALITY ASSURANCE - CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

1.4 REFERENCES AND STANDARDS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date for receiving bids, except where a specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.5 TESTING SERVICES

A. All testing shall be performed by an independent materials testing firm selected by Contractor and approved by Owner and Engineer. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified or applicable standards.

B. Testing Services paid for by Contractor. Unless otherwise specified, Contractor shall pay for all testing services in connection with the following, as incidental to the Work.
   1. Concrete materials and mix designs. Submit in accordance with Section 01300 - Submittals.
   2. Soils testing (materials gradation and moisture density tests, field compaction tests, etc.) in accordance with Section 02320 - Earthwork and Trenching.
   3. Concrete job cylinders, as specified.
   4. Concrete on-site testing. Perform concrete testing as required in Section 03300 - Miscellaneous Concrete.
   5. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work.

C. Testing, including sampling, will be performed by the testing firm's laboratory personnel, in the general manner indicated in the Specifications. Owner or Engineer, if present, shall determine the exact time, location, and number of tests, including samples.

D. Contractor shall arrange for delivery of samples and specimens for tests to the testing firm's laboratory. The testing firm's laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and shall furnish a written report of each test.

E. Contractor shall furnish all sample materials and cooperate in the sampling and field testing activities, including sampling. Contractor shall interrupt the Work when necessary to allow testing, including sampling, to be performed. Contractor shall have no claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by Engineer or the testing firm's laboratory personnel, Contractor shall furnish personnel and facilities to assist in the activities.

F. Written reports of tests shall be submitted to Engineer. Testing lab shall submit the number of copies which Contractor requires, plus three (3) copies which will be retained by the Engineer.

G. Owner may elect to provide additional testing services for the sole benefit of Owner. Testing services provided by Owner are for the sole benefit of Owner; however, test results shall be available to Contractor. Testing necessary to satisfy Contractor's internal quality control procedures shall be the sole responsibility of Contractor.

1.6 RESIDENT OBSERVATION

A. Owner will provide the Resident Project Representative or Resident Observer to perform resident observation services of all Work.

B. Cooperate with Resident Observer; furnish safe access and assistance by incidental labor as requested.

1. Notify Owner twenty-four (24) hours prior to expected time for construction operations requiring observation services.

C. Resident Observation does not relieve Contractor to perform Work to contract requirements.

1.7 OFFSITE INSPECTION

A. When the Specifications require inspection of materials or equipment during the production, manufacturing, or fabricating process, or before shipment, such services will be performed by Engineer or an independent testing firm or inspection organization acceptable to Owner.

B. Contractor shall give appropriate written notice to Owner and Engineer not less than 10 days before offsite inspection services are required, and shall provide for the producer, manufacturer, or fabricator to furnish safe access and proper facilities and to cooperate with inspecting personnel in the performance of their duties.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION

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SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, ventilation, telephone service, water and sanitary facilities.

B. Temporary Controls: Barriers, fencing, protection of the Work, damage to existing property, and water control.

C. Construction Facilities: Access roads, parking, progress cleaning, project signage, and temporary buildings.

1.2 RELATED SECTIONS

A. Section 01700 - Contract Closeout: Final cleaning.

1.3 TEMPORARY ELECTRICITY

A. Cost: By Owner; connect to Owner's existing power service. Do not disrupt Owner's use of service. Owner will pay cost of energy used. Exercise measures to conserve energy.

B. Provide temporary electric feeder from electrical service at location indicated on the Drawings. Owner's utility personnel will make service connection.

C. Power Service Characteristics: Power service and requirements may differ by site. See Drawings for electrical service at each location. Coordinate with local electrical utility.

D. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.

E. Provide main service disconnect and over-current protection at meter.

F. Permanent convenience receptacles may not be utilized during construction.

G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

1.4 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Temporary lighting, if required by Contractor, shall be provided by Contractor.

1.5 TEMPORARY VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.6 TELEPHONE SERVICE

A. Provide, maintain, and pay for telephone service to field office at time of project mobilization. Engineer and Resident Project Representative shall be allowed use of Contractor’s telephone facilities, unless separate telephone service is provided by Contractor for this purpose.

1.7 FACSIMILE SERVICE

A. Provide, maintain and pay for facsimile service and a dedicated telephone line to field office at time of project mobilization.

B. A mobile fax machine and cellular phone service, assigned to Contractor's Personnel, will be acceptable in lieu of the above.

1.8 TEMPORARY WATER SERVICE

A. Connect to existing water source for construction operations at time of project mobilization.

B. Owner will pay for cost of water used. Make efforts to conserve water.

1.9 TEMPORARY SANITARY FACILITIES

A. Contractor shall furnish temporary sanitary facilities at each site, as provided herein, for the needs of all construction workers and others performing work or furnishing services on the Project.

B. Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent.

C. If toilets of the chemically treated type are used, at least one toilet will be furnished for each 20 men. Contractor shall enforce the use of such sanitary facilities by all personnel at the site.

1.10 BARRIERS

A. Provide barriers to prevent unauthorized entry to hazardous construction areas to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.11 FENCING

A. All existing fences, affected by the Work, shall be maintained by Contractor until completion of the Work.

B. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the Engineer and alternative temporary fencing has been agreed upon.

C. Prior to final acceptance, Contractor shall restore all fences to their original or to a better condition, as specified in the fencing specifications, and to their original location, unless indicated otherwise on the Drawings.

1.12 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

1.13 EXTERIOR ENCLOSURES

A. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.14 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

1.15 DAMAGE TO EXISTING PROPERTY

A. Contractor will be held responsible for any damage to existing structures, Work, materials or equipment, because of his operations, and shall repair or replace any damaged structures, Work, materials or equipment to the satisfaction of, and at no additional cost to Owner.

B. Contractor shall protect all existing structures and property from damage, and shall provide bracing, shoring or other work necessary for such protection.

C. Contractor shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or men to or from the Work. Contractor shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

1.16 PARKING

A. Arrange for temporary parking areas to accommodate construction personnel.

B. When site space is not adequate, provide additional off-site parking.

1.17 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and rubbish from site periodically and dispose off-site.

1.18 PROJECT IDENTIFICATION

A. Contractor, at his/her option, may erect one project sign on the site for the duration of the Project. Sign shall be no larger than 25 square feet in size and shall meet all applicable local codes. Sign shall give project title, and names of the Contractor, Owner, and Engineer.

B. Erect on site at location acceptable to Owner.

C. No other signs are allowed without Owner permission except those required by law.

1.19 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment.

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Transportation and handling.

C. Storage and protection.

D. Installation and Operation.

E. Product options.

F. Substitutions.

G. Equipment Function and Controls.

H. Lubricants.

I. Warranties.

J. Extended Warranties.

1.2 RELATED SECTIONS

A. Instructions to Bidders: Product options and substitution procedures.

B. Section 01750 - Starting of Systems

1.3 PRODUCTS

A. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

B. Provide interchangeable components of the same manufacturer for components being replaced.

1.4 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

A. Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.

B. Store and protect Products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive Products in weather tight, climate controlled enclosures, in an environment favorable to Product.

E. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings, shall be stored in weather tight structures maintained at a temperature above 60°F. Equipment, controls and insulation shall be protected against dust, moisture and water damage.

F. For exterior storage of fabricated Products, place on sloped supports above ground.

G. Provide insured off-site storage and protection when site does not permit on-site storage or protection.

H. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of Products.

I. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

J. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement or damage.

K. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.

1.6 INSTALLATION AND OPERATION

A. Equipment shall not be installed or operated, except by or with the guidance of qualified personnel having the knowledge and experience necessary to obtain proper results. When so specified, or when employees of Contractor or his Subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

B. Qualified field representatives shall be provided by the equipment manufacturers, as required, to perform all manufacturer's field services called for in the Specifications.

C. Manufacturer's field representatives shall observe, instruct, guide and direct Contractor's erection or installation procedures, or perform an installation check, as required. The field representative shall revisit the site as often as necessary to attain installation satisfactory to Engineer.

D. All equipment installed under this Contract shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.

E. Acceptance of Work, in connection with the installation of equipment furnished by others, will be subject to approval of the field representative. Contractor shall be responsible for planning,

supervising and executing the installation of Work, and the approval or acceptance of Engineer will not relieve Contractor of responsibility for defective Work.

1.7 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers where substitutions are not Prohibited: Submit a request for substitution for any manufacturer not named, in accordance with the following article.

C. Products Specified by Naming One or More Manufacturers and Prohibiting Substitutions: No substitutions shall be permitted.

D. Products Designated as Base Bid Equipment in the Bid Form: No substitutions will be permitted for base bid equipment after execution of the Agreement. Proposed substitutes for base bid equipment, may be submitted to Engineer for consideration during the bid advertisement period, subject to the time limitations and requirements set forth in the Instructions to Bidders. In such case, the following article shall not apply to substitutes for base bid equipment items.

1.8 SUBSTITUTIONS

A. The term "Substitutions", as discussed under this subpart, applies to any product which is not named in the specifications and which is proposed by Contractor as an "or-equal" item or a "substitute" item.

B. No substitutions will be permitted for base-bid equipment. Bidders may propose substitutes for base bid equipment items during the advertisement period, as set forth in the Instructions to Bidders.

C. Engineer will consider requests for Substitutions only within 45 days after date established in Notice to Proceed.

D. Substitutions may be considered at any time after Notice to Proceed when a Product becomes unavailable through no fault of the Contractor.

E. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents. Contractor shall indicate if his request is intended as an "or-equal" item or a "substitute" item.

F. A request constitutes a representation that the Contractor:
   1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
   2. Will provide the same warranty for the Substitution as for the specified Product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.
   5. Will reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities.

G. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.

H. Substitution Submittal Procedure: As set forth in Article 6.05 of the General Conditions, and as modified below:
   1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
   2. Submit shop drawings, product data and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

1.9 EQUIPMENT FUNCTION AND CONTROLS

A. The Contract Drawings and Specifications present operational descriptions, sequences of operation, circuit diagrams, and component requirements for automated equipment and control systems. These have been prepared by Engineer to communicate the design intent and aid in bidding the Work. This information is not necessarily detailed enough to serve as installation guides for wiring equipment and controls components. It is the responsibility of Contractor and Contractor's electrical subcontractor to:
   1. Coordinate among themselves and the various suppliers to provide a system which functions as specified.
   2. Review shop drawings and submittals to ensure compatibility and avoid conflicts and duplication.
   3. Employ on the site at least one supervisor who is knowledgeable and experienced in electrical wiring and controls, and who can read and interpret circuit schematics and wiring diagrams, in accordance with the General Conditions. Copies of all pertinent shop drawings and submittals shall be kept on hand by workers.

B. If a supplier takes exception to the Drawings and Specifications, or proposes to modify the equipment and controls to provide what he believes is a more functional and serviceable system, Contractor shall bring such proposed changes to the attention of Engineer as early as possible, but not later than the submittal review process. By affixing his stamp of approval, Contractor certifies that he approves of all changes proposed and required by the submittal, and agrees that such changes will be made at no additional cost to Owner. Contractor may not void this certification and acceptance of additional requirements by affixing a stamp of "exceptions noted", whether or not the exceptions are delineated. If Engineer allows such changes by virtue of submittal review, Contractor shall be responsible for the resultant changes to other systems, including but not limited to additional circuits.

1.10 LUBRICANTS

A. For each pump and individual item of mechanical process equipment, the manufacturer shall furnish to Owner all oils, greases, and other lubricants recommended for proper operation in sufficient quantities to last for two years at manufacturer's suggested schedule of maintenance and lubrication, under normal operating conditions. These quantities shall be in addition to that required by Contractor for start-up and commissioning. All containers shall be clearly labeled with product name and name of associated equipment.

1.11 WARRANTIES

A. For warranties by suppliers or manufacturers of materials and equipment, it shall be understood, unless specifically stated in the individual section, that:
   1. Warranties shall be for a period of one (1) year and shall commence on the date of Substantial Completion.
   2. Warranties shall be in the name of the Owner.
   3. Replacement is full and not prorated.
   4. Manufacturer's or supplier's liability cannot be limited to some arbitrary value selected by the manufacturer or supplier.

5. Owner will cover the cost of equipment delivery to the manufacturer's or supplier's local service center that covers the Richmond, Missouri area. Manufacturer or supplier shall cover return shipping.
6. If Owner makes a claim against the warranty for a defect in manufacturing or installation, it shall be the responsibility of the manufacturer or supplier to prove the claim is NOT a cause of a defect in manufacturing or installation. If the manufacturer or supplier cannot prove the claim is not a result of defect in manufacturing or installation, the claim shall be honored.

1.12 EXTENDED WARRANTIES

A. Certain items require extended warranties as set forth in individual sections. It is the intent that this extended warranty be provided by the manufacturer of the equipment or item. Contractor is directly responsible for installation and performance of equipment during the one year correction period. After the one year, Owner will pursue equipment warranty matters directly with the respective manufacturers, unless it becomes evident that the equipment was improperly installed by the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Project record documents.

D. Operation and Maintenance Data.

E. Spare Parts and Maintenance Products.

1.2 RELATED SECTIONS

A. Section 01500 - Construction Facilities and Temporary Controls.

1.3 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.

B. Submit final Application for Payment identifying total adjusted Contract Price, previous payments, and sum remaining due.

1.4 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean site, remove waste and surplus materials, rubbish, and construction facilities from the site.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed Shop Drawings, Product Data, and Samples.
   6. Manufacturer's Instructions for Assembly, Installation, and Adjustments.

B. Ensure entries are complete and accurate, enabling future reference by Owner and Engineer.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Details not on original Contract drawings.
   2. Record Drawings shall be maintained and updated throughout the Work, and presented at each progress meeting for review.

G. Submit documents to Owner with claim for final Application for Payment.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit data bound in 8-1/2x11 inch (A4) text pages, in D side ring binders (binding rings mounted on back cover) with durable plastic covers. All binders shall be same size, style, and color. Binders shall be no more than 75 percent full.

B. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.

C. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

D. Information contained in Operation and Maintenance Instructions shall be specific to the products provided under this Contract. If data sheets, manuals, diagrams and other information applies to several models or types, the applicable model shall be clearly indicated and the information which does not apply shall be crossed out. Furnished options, including materials options, shall be clearly indicated.

E. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, typed on 20 pound white paper, in three parts as specified below. Additional requirements given in individual specification sections shall also apply.
   1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and equipment Suppliers.
   2. Part 2: Operation and Maintenance Instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
      a. Significant design criteria.
      b. List of equipment
      c. Parts list for each component, with arrangement diagram.
      d. Spare parts
      e. Operating instructions
      f. Maintenance instructions for equipment and systems
      g. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
      h. Warranties
      i. Copies of equipment start-up reports certified by manufacturer's representative with start-up dates.
   3. Part 3: Project documents and certificates, including the following:
      a. Shop drawings and product data
      b. Air and water balance reports
      c. Originals and Photocopies of warranties and any guarantees.

F. Timing of Submittals:

1. At 90 percent completion, Contractor shall assemble two (2) complete copies of Operations and Maintenance Instructions. This 90 percent draft shall contain operation instructions, maintenance data, and warranties for all equipment and other items requiring such. Contractor shall not submit Operations and Maintenance Instructions as individual sections or in a "piece meal" fashion. Contractor shall submit complete volumes of the manuals as specified herein.
   a. Note: Engineer will not begin review of draft Operations and Maintenance Instructions until shop drawing and data submittals have been submitted and corrected in accordance with Section 01300 - Submittals.
   b. This draft copy will be reviewed and returned, with Engineer comments and directions for arrangement.
   c. Revise manuals per Engineer comments. Revise 90 percent documents also to reflect changes made during start-up and commissioning.
2. Submit four (4) sets of revised final volumes, prior to final inspection. Contractor shall revise Operation and Maintenance Manuals as required and directed by Engineer to reflect changes made prior to final completion. One set will be retained by the Engineer, and three sets will be retained by Owner. Deliver final volumes to Engineer and Owner. Final volumes must be received by Engineer prior to application for final payment.

1.7 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide maintenance, and extra products in quantities specified in individual specification sections.

B. Contractor shall store and be responsible for all spare parts and furnished lubricants until acceptance by Owner at final completion. No materials shall be turned over to Owner before this time. Contractor shall organize spare parts and ensure that parts are neatly packaged and clearly and permanently labeled with description, supplier name, and project manual section number.

C. Contractor shall meet with Owner to hand over spare parts all at once. Contractor will provide a written log which will be initialed by Contractor and Owner. Items missing from the list of parts required by Contract Documents shall be delivered to Owner prior to application for final payment. Items which are damaged shall be replaced by Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01750

STARTING OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Starting Systems.

B. Manufacturer's Field Services

C. Demonstration and Training.

D. Testing, Adjusting and Balancing.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals: Manufacturers field reports.

B. Section 01700 - Contract Closeout: System operation and maintenance data and extra materials.

1.3 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Engineer seven days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute start-up in accordance with manufacturers' instructions, and under supervision of manufacturer's representative, if required.

1.4 MANUFACTURER'S FIELD SERVICES

A. An experienced, competent and authorized representative of the manufacturer of each item of equipment for which start-up services are indicated in the specification sections shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation.

B. The manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

C. Each manufacturer's representative shall furnish to Engineer, through Contractor, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated

under full load conditions; and that it operated satisfactorily. Copies of this report shall be included with the O&M manuals.

D. All costs for these services shall be included in the Contract Price.

1.5 DEMONSTRATION AND TRAINING

A. Demonstrate general operation of Products to Owner's personnel at start-up.

B. Demonstrate Project equipment and instruct in a classroom environment located at the wastewater treatment facility and instructed by a qualified manufacturers' representative who is knowledgeable about the specific equipment and systems on this Project. The training session shall occur on a separate visit from start-up services, unless otherwise permitted by Engineer and Owner.

C. Timing of Training: Contractor shall schedule training sessions for all required systems.
   1. No more than two equipment system training programs per week shall be scheduled.
   2. Training programs may commence individually at start-up of a given system. All sessions need not be complete to meet the contract deadline for final completion, but all must be completed prior to Owner making final payment to Contractor.
   3. Contractor shall submit proposed schedule to Engineer at least 2 weeks prior to first scheduled session. Engineer will review with Owner and may require Contractor to revise and resubmit to conform to Owner's schedule.

D. Utilize Operation and Maintenance Manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
   1. If final Operation and Maintenance manuals are not yet available when start-up occurs, provide additional copies of draft Operation and Maintenance Instructions for use by Owner's personnel.

E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance and shutdown of each item of equipment at scheduled time.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.6 TESTING, ADJUSTING, AND BALANCING

A. Contractor shall employ services of an independent firm to perform testing, adjusting and balancing.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02205

TEMPORARY EROSION & SEDIMENT CONTROL

PART 1 GENERAL:

The Contractor shall furnish all labor, material, equipment, and service necessary to construct, maintain, and remove the erosion control measures as shown on the drawings and specified herein. It shall be the Contractor's responsibility to ensure the construction site and construction practices comply with Missouri law and regulation regarding land disturbance activities, including developing a Stormwater Pollution Prevention Plan (SWPPP) and obtaining a land disturbance permit from the Missouri Department of Natural Resources if such a permit is required for construction.

PART 2 STRAW BALE BARRIER:

2.1 DESCRIPTION:

Bales of straw placed and secured in a row to intercept and detain sediment.

2.2 CONSTRUCTION:

Bales shall be placed in a single row, lengthwise and embedded in the soil in a depth of 3 inches. Bales must be securely anchored in place by stakes or re-bars driven through the bales or by other acceptable means to prevent displacement. Any damage to barrier must be repaired promptly as needed.

PART 3 SILT FENCE:

3.1 DESCRIPTION:

Geotextile Filter Fabric buried at the bottom, stretched, and supported by posts to intercept and detain sediment.

3.2 MATERIALS:

A. Geotextile Fabric:

Fibers used in the manufacture of geotextiles shall consist of longchain synthetic polymers, composed of at least 85 percent by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. The geotextile shall be free of any treatment or coating which might adversely alter its physical properties after installation. Unless otherwise specified, geotextile shall be furnished in 36 inch width rolls.

B. Protection:

Geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements.

C Posts:

Either wood, steel, or synthetic posts may be used. Posts shall have a minimum length of 48 inches plus embedment depth and be of sufficient strength to resist damage during installation and to support applied loads.

C. Support Fence:

Wire or other support fence shall be at least 24 inches high and strong enough to support applied loads.

D. Prefabricated Fence:

Prefabricated fence systems may be used provided they meet all of the above material requirements.

3.3 CERTIFICATION AND SAMPLING:

The contractor shall furnish a manufacturer's certification, in triplicate, stating that the material supplied conforms to the requirements of these specifications. The certification shall include or have attached, typical results of tests for the specified properties, representative of the materials supplied. The engineer reserves the right to sample and test any material offered for use. Acceptance will be based on the certification and the results of any tests the engineer may perform.

3.4 CONSTRUCTION REQUIREMENTS:

A. General:

The contractor shall install a temporary silt fence as site conditions require. Fence construction shall be adequate to handle the stress from hydraulic and sediment loading. Geotextile at the bottom of the fence shall be buried as indicated on the standard drawings. The trench shall be backfilled and the soil compacted over the geotextile. The geotextile shall be spliced together as indicated on the standard drawings.

B. Post Spacing:

Post spacing shall not exceed 8 feet for wire support fence installations or 5 feet for self-supported installations. Posts shall be driven a minimum of 24 inches into the ground. Where rock is encountered posts shall be installed in a manner approved by the engineer. Closer spacing, greater embedment depth and/or wider posts shall be used as necessary in low areas and soft or swampy ground to ensure adequate resistance to applied loads.

C. Fencing:

When support fence is used, the mesh shall be fastened securely to the up-slope side of the post. The mesh shall extend into the trench a minimum of 2 inches and extend a maximum of 36 inches above the original ground surface. When self-supported fence is used, the geotextile shall be securely fastened to fence posts.

D. Maintenance:

It is the contractor's responsibility to maintain the integrity of silt fences as long as they are necessary to contain sediment runoff. The contractor shall inspect all temporary silt fences immediately after each rainfall and at least daily during prolonged rainfall. Any deficiencies shall be immediately corrected by the contractor. In addition, the contractor shall make a daily review of the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as approved or directed by the engineer. The contractor shall remove and dispose of sediment deposits when the deposit approaches one-half the height of the fence or sooner when directed by the engineer. If required by heavy sediment loading, a second silt fence shall be installed as directed by the engineer.

E. Removal:

The silt fence shall remain in place until the work for which is was installed has been completed. Upon removal, the contractor shall remove and dispose of any excess silt accumulations, grade and dress the area to the satisfaction of the engineer, and establish vegetation on all bare areas in accordance with the contract requirements.

F. Physical Requirements for Temporary Silt Fence Geotextiles:

Physical requirements shall conform to the following table:

Property	Test Method	Wire Fence Supported Requirements	Self-Supported Requirements
Tensile Strength, lbs.	ASTM D4632	90, minimum	90, minimum[2]
50% Minimum Tensile Strength (45 lbs.)	ASTM D4632	N/A	50 maximum
Filter Efficiency, %	VTM-51[3]	75	75
Flow Rate, gal/ft^2/min.	VTM-51[3]	0.3	0.3
Ultraviolet Degradation at 500 hrs	ASTM D4355	70% strength retained, minimum	70% strength retained, minimum

Note:

1. All numerical values represent minimum average roll value.
2. When tested in any principal direction.
3. Virginia DOT test method.

PART 4 SUBMITTALS:

The Contractor shall submit for approval the following items required by this Section:

- Geotextile Fabric

END OF SECTION

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SECTION 02320

EARTHWORK & TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall perform all excavation, embankment, trenching, backfilling, cushioning, surface dressing, dewatering, shoring, surface restoration and disposal of waste as required for site grading, structures, piping, and appurtenances as shown on the Drawings.

1.2 SECTION INCLUDES

A. Pipe Embedment Material.

B. Crushed Rock.

C. Fill Materials.

D. Impervious Trench Check Material.

E. Classification of Materials

F. Site Clearing.

G. Subgrade Preparation.

H. Earthfills and Embankments.

I. Excavation.

J. Pipe Embedment Schedule.

K. Backfilling.

L. Surface Restoration.

M. Disposal of Materials.

N. Soil Testing.

1.3 RELATED SECTIONS

A. Section 02530 - Piping System Products.

B. Section 02535 - Piping Systems Installation.

C. Section 02922 - Seeding.

D. Section 03300 - Miscellaneous Concrete.

1.4 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. American Society for Testing Materials (ASTM):
1. D-698 - Moisture-Density Relations Of Soils, Using 5.5 Pound (2.5 kg) Rammer And 12-Inch (304.8 mm) Drop.
2. D-1140 - Test Method for Amount of Material in Soils Finer Than the No. 200 (75μm) Sieve.
3. D-2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. D-3017 - Standard Test Methods for Water content of Soil and rock by Nuclear Methods.

1.5 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Section 01300 - Submittals.

A. Product data for review: Soil test results as specified herein for soil testing.

1.6 DEFINITIONS

A. Earth excavation: Earth excavation is defined as the removal of all material whose removal is not defined as rock excavation.

B. Pipe embedment: Pipe embedment is defined as soil or stone aggregate material placed under, around, and in some cases over the pipe. The material type and extent of embedment is specified herein and shown on the Drawings.

C. Trench backfill: Trench backfill is defined as soil or stone aggregate material placed in a pipe or utility trench, above the pipe embedment and up to the existing ground surface, finished grade, or the bottom of pavement.

D. Structure backfill: Structure backfill is defined as soil or stone aggregate material placed around or above subsurface structures, such as manholes, vaults, foundations, and wetwells.

1.7 MAINTENANCE OF WORK: The Contractor shall be responsible for the satisfactory compaction and maintenance of all completed excavation, embankment, and backfill. If, prior to the expiration of the General Guaranty period stipulated in the Front End Documents, any grades or subgrades are found to have settled or eroded, they shall be reworked immediately by the Contractor and restored to the specified grades, and the surface restored.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials shall conform to the respective references listed above and other requirements specified herein.

B. Topsoil, and material required for structural backfill and trench backfill in excess of suitable material excavated from trenching and structural excavation shall be furnished by the Contractor at no additional cost to the Owner.

2.2 PIPE EMBEDMENT MATERIAL: Granular Embedment Material: Granular embedment material for installation in pipe trenches and other locations indicated on the Drawings shall be crushed stone conforming to the 2007 MCIB Concrete Standards, Section 2.1.D for coarse aggregate meeting the gradation specified under Column IV, Table 2.1.D-1 for 2-inch aggregate with the modification that the maximum allowable

percentage of material finer than No. 200 sieve shall be between 2.0% and 5.0% as determined by ASTM C-117. The gradation is repeated below for information:

Sieve Size	Percent Passing
3/4"	100
1/2"	80 - 100
3/8"	40 - 70
No. 4	0 - 15
No. 8	0 - 5
No. 200	0 - 3

2.3 CRUSHED ROCK: Crushed rock for use beneath concrete slabs and structures, and in other locations shown on the Drawings, shall be freely draining, siliceous gravel or crushed stone aggregate, conforming to 1999 Missouri Standard Specifications for Highway Construction, Section 1007, Type 1007.4.3. The gradation is repeated below for information:

Sieve Size	Percent Passing
1"	100
1/2"	55 - 90
No. 4	8 - 40
No. 10	0 - 15
No. 200	0 - 4

2.4 FILL MATERIALS

A. Random Fill Material: Random fill material for earthfills, embankments and other uses, shall be a soil material which is free from: rocks or stones larger than 6 inches in greatest dimension, brush, stumps, logs, roots, debris, top soil, and organic or harmful materials. The portion of fill material passing the No. 40 sieve shall have a liquid limit not exceeding 40 and a plastic limit not exceeding 25, when tested in accordance with ASTM D-4318. To the extent possible, site excavated material may be used. Random fill material shall be imported if suitable soil material is not available on site.

B. Select Fill Material: Select fill material shall be a sorted, job-excavated or imported soil material as specified for random backfill material, except no rocks, stones, or lumps larger than one inch in largest dimension shall be present. Select fill material, used for filling beneath or against structures, shall not contain weathered shale.

C. Granular Fill Material:
1. Granular fill material shall be a densely graded gravel of the following gradation:

Sieve Size (square opening)	Percent Passing (by weight)
1 inch	100
3/4 inch	85 - 100
3/8 inch	50 - 80
No. 4	35 - 60
No. 40	15 -25
No. 200	5 -15

2. Granular fill material shall be free from clay lumps or organic matter. The fraction passing the No. 4 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. The fraction passing the No. 200 sieve shall not exceed 3/4 of the fraction passing the No. 40 sieve.

2.5 IMPERVIOUS TRENCH CHECK MATERIAL

A. Material for impervious trench checks shall be naturally occurring clay or a soil and sodium bentonite mixture with the permeability of the material to be no greater than $10x10^{-6}$ cm/sec.

B. Material shall be free of any stones, bricks, concrete, etc., except gravel or crushed rock of 3/4 inch size or less.

PART 3 EXECUTION

3.1 PREPARATION

A. The Contractor shall verify that required lines, levels, contours and datum are as shown in the plans.

B. Grading, excavation and backfilling shall be made to the lines, grades and cross sections indicated in the plans.

C. The Contractor shall maintain the site and conduct earthwork operations to ensure that the property is well drained at all times. The Contractor shall protect adjacent and downstream properties from damage or pollution caused by erosion. The Contractor is responsible for erosion control measures and methods and shall conduct earthwork operations to ensure the protection of all downstream and adjacent properties. The Contractor shall implement any additional erosion control measures to prevent damage.

D. Existing Utilities:
1. The Contractor shall verify the location and depth of all utilities a minimum of 24 hours prior to construction. The Contractor may utilize the toll free number for the "Missouri One Call System" 1-800-344-7483. This number is applicable anywhere within the state of Missouri. Prior to commencement of work the Contractor shall notify all those companies which have facilities in the vicinity of the construction.
2. Coordinate removal or relocation of existing utilities with their Owner.
3. Locate, identify and protect utilities that remain from damage. The Contractor shall make every reasonable effort to protect all existing utilities from damage. If any utility is damaged through the carelessness or negligent actions of the Contractor, the utility shall be repaired by its owner at the Contractor's expense.

4. Abandoned pipes which the Drawings indicate shall be capped or filled do not need to be removed. All other abandoned pipe conduit within the limits of grading shall be removed by the Contractor

E. Existing fences: Fences within the construction grading area shall be removed and reconstructed to equal or better quality than that of the fence removed. It shall be the sole responsibility of the Contractor to maintain all gates, fences, cattle guards and the like encountered during construction, as required to prevent the straying of pets and livestock.

3.2 CLASSIFICATION OF MATERIALS: No classification of excavated materials, regardless of type or condition, will be made for purposes of payment. All excavation shall be unclassified unless designated otherwise. Excavation and trenching work shall include the handling and removal of all materials, regardless of its nature, excavated or removed from the site in performance of the Work.

3.3 SITE CLEARING

A. Clearing and stripping: All stumps, roots, buried logs, foundations, drainage structures, or other miscellaneous debris occurring within the limits of the excavation and site grading shall be removed as part of the grubbing operations and disposed of by, and at the expense of, the Contractor. Like-wise, six inches of topsoil shall be stripped from the disturbed construction areas and stockpiled for later use in final grading.

B. Stumps and roots in excavated or fill areas where depth of fill does not exceed 3 feet shall be removed to a depth of 18 inches below subgrade. In fill areas where more than 3 feet of fill is required, roots and stumps shall be cut off at the face of the excavation.

3.4 SUBGRADE PREPARATION

A. Proof-roll subgrade below building slabs, tank slabs, and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
4. Subgrades under building slabs shall be compacted in place to 95 percent of maximum density as determined by ASTM D-698, at a moisture content within ±2 percent of optimum.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.5 EARTHFILLS AND EMBANKMENTS

A. Material and Compaction Requirements:
1. Fill areas which are below structures, concrete slabs, or paved areas, and within 5 horizontal feet of a structure or concrete slab shall be filled with select fill material, as specified herein, unless otherwise indicated on the Drawings. The select fill material shall be placed in lifts not exceeding 12 inches in compacted thickness, and shall be compacted to a minimum 95 percent of maximum density as determined by ASTM D-698. Fill shall be placed and compacted at a moisture content within ± 2 percent of optimum.
2. Fill areas which are outside the envelope described above shall be filled with random fill material, as specified herein, unless otherwise indicated on the Drawings. The random fill material shall be placed in lifts not exceeding 12 inches in compacted thickness, and shall

be compacted to a minimum 90 percent of maximum density as determined by ASTM D-698. Fill shall be placed and compacted at a moisture content within ± 3 percent of optimum.

a. For areas which will be surfaced with gravel, the top two feet of random fill shall be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-698. Fill shall be placed and compacted at a moisture content within ± 2 percent of optimum.

B. All vegetation and topsoil, and any loose, unstable or unsuitable material shall be removed from the existing surface to receive fill material. After stripping, the area shall be proof-rolled with a loaded tandem axel dump truck, or other equipment acceptable to Engineer. Unstable materials located by proof-rolling, shall be removed and replaced with suitable compacted fill material.

C. Before placing any fill the existing surface shall be scarified, moisture conditioned as required and the top 6 inches compacted to 90 percent of the maximum density for that material in accordance with ASTM D-698.

D. When embankments, regardless of height, are placed against hillsides or existing embankments having a slope steeper than 1 vertical to 4 horizontal, the existing slope shall be benched or stepped in approximately 24 inch rises. The material shall be bladed out and the bottom area cut to form benches and the embankment material being placed shall be compacted to the specified density. Formation and compaction of benches shall not be measured and paid for directly but will be considered incidental work.

E. Where embankments of two feet or less are placed over existing pavement, the existing pavement shall be removed and the cleared surface compacted to the specified density. Where embankments greater than two feet are placed over existing pavement, the pavement shall be broken into pieces with a maximum dimension of 24 inches and the pieces left in place.

F. Do not place fill material over porous, wet, frozen or spongy surfaces. Embankment construction shall not be performed when fill material is frozen or contains frost or snow.

G. Placement: Place earth embankments in successive horizontal lifts uniformly distributed over the full width of the fill area. Each lift shall not exceed the specified thickness and shall be compacted to the specified density prior to placing any additional lifts. As compaction of each layer progresses, continuous blading and dozing will be required to level the surface and ensure uniform compaction.

H. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so they do not interfere with proper compaction, as determined by the Engineer.

3.6 LAGOON CONSTRUCTION NOT USED

3.7 EXCAVATION

A. General:

1. Where necessary, satisfactory sheeting and bracing shall be used to hold the sides of the excavation at all points where damage might result from slides.
2. All sheeting and bracing shall be removed as the backfill is placed, unless otherwise directed in writing by the Owner or shown on the Drawings. All voids left or caused by the withdrawal of sheeting shall be filled immediately with suitable material and tamped.
3. Excavation below structure or trench subgrade:
   a. Over excavation of pipe trenches due to Contractor's oversight, shall be backfilled with granular embedment material compacted in 8-inch lifts to 90

percent of the maximum density for that material in accordance with ASTM D-698, as required at no additional cost to the Owner.

b. Over excavation of structure subgrades due to the Contractor's oversight, shall be replaced with concrete placed monolithic with the structure above at no additional cost to the Owner.

c. When unstable or unsuitable material is encountered in the subgrade, such material shall be removed, replaced with crushed rock (for structures) or granular pipe embedment material (for trenches) and compacted to the density equal to or greater than required for subsequent backfill material. Such excavation and backfill shall be paid for at the contract unit price.

d. When the subgrade bottom is soft and in the opinion of the Engineer cannot support the foundation, a further depth and/or width shall be excavated and refilled to the desired pipe or foundation grade with crushed rock, as required by the Engineer to assure a firm foundation. Such excavation and backfill shall be paid for at the contract unit price.

4. Use of Explosives: The use of explosives is prohibited

5. Dewatering: Each excavation shall be kept dry during subgrade or pipe embedment preparation, and continually thereafter until the structure or pipe is completely installed, to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

a. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level at least 12 inches below the bottom of the excavation.

b. Trenches shall be drained so that workmen may work efficiently. The discharge of pumps used for draining the trenches shall be led to natural drainage courses or drains.

B. Structure Excavation:

1. Excavation for structures shall be performed to the limits indicated on the Drawings.

2. All suitable material removed by excavation shall be used as far as practicable for backfill and embankment as required to complete the work. The Contractor shall sort all excavated material and stockpile suitable material as necessary. Stockpile excavated material to be used as fill and backfill in area designated on site and remove excess material or unsuitable material not being reused, from site.

C. Trenching:

1. The Contractor shall not open more trench in advance of the pipe laying than is necessary. The length of open trenches shall be limited depending on the nature of the soil and safety considerations. All open trenches shall be adequately protected using fencing, barricades, etc. as required.

2. Trenches shall be excavated within the limits of public right-of-way in conformance with the requirements herein. Trenches shall be excavated to the width and depth necessary to install sewer pipe to the lines, grades and elevations shown on the Drawings.

3. In those areas designated to be landscaped, seeded or sodded, the top soil shall be excavated, stockpiled and replaced as specified herein.

4. The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. 300 feet shall be the maximum allowable length of open trench ahead of pipe laying.

5. Limiting trench widths: Trenches shall be excavated to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and placement and compaction of embedment. Unless otherwise noted on the drawings, the limiting trench widths below an elevation 12 inches above the top of the installed pipe shall be as follows:

Pipe Size (inches)	Minimum Trench Width (inches)	Min. Clearance on Each Side of Pipe (inches)	Maximum Trench Width (inches)
< 4	20	6	26
4 - 6	22	6	30
8	22	6	30
10	24	6	32
12	27	6	36
15	30	6	38
16	32	6	40
18	34	6	42
20	36	6	44
36	50	6	60
48	62	6	72

6. Unauthorized trench widths: Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing table, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.
7. Trench bottom in earth: The trench in earth shall have a flat bottom the full width of the trench and shall be excavated to the grade to which the embedment is to be laid. The surface shall be graded to provide a uniform bearing and continuous support. No part of the bell shall be in contact with the trench bottom.
8. The Contractor shall sort and stockpile excavated material so that suitable material is available for backfill. Excavated material shall be deposited on the side of the trenches and beyond the reach of slides. Excavated material not suitable for backfill shall be promptly removed from the site.
9. Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes, but sloping trench walls shall not extend lower than 1 foot above the top of the pipe.
10. Trench Shields: Where trench shields are used by the Contractor, no part of the shield shall exceed lower than 6 inches above the top of the pipe, nor shall the maximum allowable trench width be exceeded.

3.8 PIPE EMBEDMENT

A. Embedment Classes: Unless otherwise indicated on the drawings, embedment classes shall be as follows, and as detailed on the Drawings. All lifts are given in compacted thickness. All compaction percentages refer to maximum dry density as determined by ASTM D-698. Select fill material shall be compacted within 2% of optimum moisture content. Select fill material shall be replaced with granular fill material if granular fill material is required for trench fill to ground surface.

1. Class A Embedments:
   a. Class A-1 embedment shall provide a cradle of concrete with a compressive strength of at least 3,000 psi, as specified in Division 3 - Concrete. After the initial set of the concrete, granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%, above the top of pipe.
   b. Class A-2 embedment shall provide an arch of concrete with a compressive strength of at least 3,000 psi, as specified in Division 3 - Concrete. Granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%, up to the centerline of the pipe. A concrete arch shall be placed on the granular embedment. After the concrete has set, one foot of select fill material shall be placed above the top of pipe, compacted in 8-inch lifts to a minimum of 85%.
2. Class B Embedments:

a. Class B-1 embedment shall provide an encasement of granular embedment material, extending below the pipe to above the top of pipe. Granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%.

b. Class B-2 embedment shall provide a cradle of granular embedment material which shall be placed in 6-inch lifts and compacted to a minimum of 90%. Select fill material shall then extend above the top of the pipe, placed in 8-inch lifts and compacted to 85%.

3. Class C Embedment: Materials and compaction requirements shall be as for Class B-2.

4. Class D Embedment: Shall allow the pipe to rest on a flat or restored trench bottom. Pipe embedment shall be select fill material extending from the bottom of the pipe to above the top of pipe, placed in 12-inch lifts and compacted to 85%.

5. Class E Embedment: Shall provide a cradle of granular embedment material which shall be placed in 6-inch lifts and compacted to a minimum of 90%. Select fill material shall then extend above the top of the pipe, placed in 12-inch lifts and compacted to 85%.

B. Concrete Encasement: Where indicated on the Drawings, concrete encasement shall be provided instead of the pipe embedment classes specified herein. Requirements for concrete encasement are detailed on the Drawings. Concrete and reinforcement shall be as specified in Division 3 - Concrete, for 3,000 psi concrete.

C. Pipe Embedment Class Schedule: Unless otherwise noted on the Drawings, pipe embedment classes shall be provided according to the following schedule:

Pipe Material	Depth over pipe (feet)	Embedment class
SDR-35 PVC	All	B-1
Class 200 PVC in soil	All	D
Class 200 PVC in rock	All	E
SDR-PR PVC, SCH 40/80 PVC	All	B-1
C-900 PVC	All	B-1
HDPE (polyethylene)	All	B-2
DIP in soil up to 12-inch	minimum 3 ft	D
DIP in soil over 12-inch	minimum 3 ft	E
DIP in rock, all sizes	minimum 3 ft	E
Copper	All	E
Reinforced Concrete Pipe (RCP)	All	E
Other types not listed here	All	B-2

D. Placement of Embedment:

1. Place embedment material at the trench bottom with proper allowance for bell joints. Level materials in continuous layers not exceeding 6 inches in compacted depth. Shovel slicing of embedment shall be performed along the sides of the pipe as embedment is placed, to consolidate the bedding and haunching below the pipe.

2. Consolidate granular embedment by rodding, spading and compacting as necessary to provide uniform pipe support and meet the compaction requirement.

3.9 CRUSHED ROCK: Crushed rock shall be placed when shown on the Drawings or specified herein. Crushed rock shall be placed on suitably prepared subgrade and compacted by vibration. Crushed rock shall be kept

free from dust, clay or trash. Crushed rock shall be compacted to not less than 90 percent of the maximum density for that material in accordance with ASTM D-1557.

3.10 BACKFILLING

A. General:

1. All trenches and excavations around structures shall be backfilled to finish grade according to the Drawings. Backfill with material as specified herein.
2. Large compaction equipment, including self-propelled compaction equipment, bulldozers, loaders, and boom-mounted vibratory plates, shall not be used within 3 feet above the top of pipe, or within 3 feet of new or existing structures.
3. If backfilling operations do not meet the specifications, the material shall be removed, replaced and recompacted at the Contractor's expense.
4. Backfill shall not be placed when material is frozen, contains frost, snow, waste material, trees, organic matter and rubbish or when the surface to receive backfill is snow
5. No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum compressive strength of 2,000 psi and can support the loads imposed by backfilling and traffic.

B. Trench backfill: Backfill for all pipeline trench excavation shall be placed by the end of each working day around all pipe laid that day, leaving only the working end of the pipe uncovered. Any trenches excavated in advance of pipe laying shall also be backfilled at the end of each working day.

1. For trenches beneath proposed structures, slabs, or in areas which have or will have a paved or chip-and-seal surface, or where indicated on the Drawings to use granular fill material:
    a. Granular fill material shall be shall be placed on the compacted pipe embedment, in layers not to exceed 12 inches in compacted thickness.
    b. Granular fill material shall be compacted by vibratory means. Each lift of granular fill shall be compacted to a minimum 95 percent of maximum density as determined by ASTM D-698. Backfill shall be placed and compacted at a moisture content within plus 2 or minus 2 percent of optimum. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.
2. For trenches in graveled areas, or other vehicle traveled ways which are neither paved nor surfaced with chip-and-seal material:
    a. Select fill material shall be placed on the compacted pipe embedment, in layers not to exceed 12 inches in compacted thickness.
    b. Select fill material shall be compacted to a minimum of 90 percent of maximum density as determined by ASTM D-698. Backfill shall be placed and compacted at a moisture content within plus 3 or minus 3 percent of optimum. Select backfill may be compacted by vibratory plates, tracks or wheels of graders, tractors, high loaders or similar equipment, subject to the restrictions above. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.
3. For trenches in other areas, including grassed areas and parkways which are not in vehicle traveled ways:
    a. Random fill material shall be placed on the compacted pipe embedment, in layers not to exceed 18 inches in compacted thickness.
    b. Random fill material shall be compacted to a minimum of 85 percent of maximum density as determined by ASTM D-698. Backfill shall be placed and compacted at a moisture content within ±3 percent of optimum. Backfill may be compacted by vibratory plates, tracks or wheels of graders, tractors, high loaders or similar equipment, subject to the restrictions above. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.

C. Structure backfill:

1. All structures shall be backfilled to the lines and grades shown on the Drawings. In no instance shall backfill be dumped, bulldozed or otherwise deposited in bulk upon the structure. Backfill shall be kept at approximately the same elevation on all sides of the structure as backfilling proceeds.
2. Structure backfill which will be beneath paved areas, slabs, or structures shall be granular fill material, compacted in place to 95% of maximum density as determined by ASTM D-698, at a moisture content within plus 2 or minus 2 percent of optimum. Granular fill shall be placed in lifts not to exceed 8 inches in compacted thickness, and compacted by careful pneumatic or vibratory tamping.
3. Backfill in all other areas shall be select fill material, placed in lifts not to exceed 12 inches in compacted thickness, and compacted in place to 90% of maximum density as determined by ASTM D-698, at a moisture content within plus 3 or minus 3 percent of optimum.

3.11 SURFACE RESTORATION

A. All areas disturbed by construction operations shall be restored by paving, gravel surfacing, or seeding, as indicated on the Drawings and specified. For areas which are seeded, minimum depth of topsoil shall be six inches. Topsoil shall be a dark, friable, organic soil free of clay lumps and rocks larger than one and half inches in largest dimension.

3.12 IMPERVIOUS TRENCH CHECK

A. Trench checks shall be placed where indicated on the Drawings, or at a maximum interval of 400 feet. If a pipeline segment is at least 100 feet but less than 400 feet, one trench check shall be provided in a location acceptable to the Engineer.

B. Trench checks shall extend the full width of the trench, and the length and depth shall be as indicated on the Drawings. Trench check material shall be placed completely under, around and above pipe, and shall be placed in maximum compacted lifts of 8 inches in thickness and compacted to 95% of maximum density as determined by ASTM D-698. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.

3.13 DISPOSAL OF MATERIALS

A. All unused excess excavated material, together with all debris, removed pipe, stones, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by the Contractor, at the expense of the Contractor.

B. Material to be disposed of, including excess material, shall be promptly removed from the site by Contractor. If Contractor desires to set aside excess excavated material free from contamination by sewage or other hazardous substances, he shall do so only in an area approved by the Owner.

3.14 SOIL TESTING: All materials, for fills and for impervious trench checks (if required), shall be sampled and tested in accordance with Section 01400 - Quality Control.

A. Laboratory Tests:

1. Two initial gradation tests and two initial moisture-density (Proctor) tests shall be made for each type of embedment, backfill, and trench check material, including job excavated materials.
    a. Initial tests on materials which are imported (not job excavated) shall be provided by Contractor and the results submitted as product data for review in accordance with the submittals section.

2. One additional gradation test and one additional moisture-density test shall be made for each additional 400 tons of imported material, and such tests shall be paid for by Contractor.

B. Field Tests:

1. During the progress of the work of filling and backfilling, in-place density tests will be performed with a nuclear density gage by a qualified laboratory technician.
2. The number of tests to be taken and the locations thereof shall be determined by the Engineer based upon observation of the filling or backfilling process. A minimum of two (2) tests per 100 cubic yards of fill/backfill and two (2) tests per 300 feet of trench will be taken unless otherwise directed by the Engineer. One additional test will be performed on each trench check (if required).
3. If the tests indicate the compaction is not sufficient, the Contractor shall increase the compactive effort on all such inadequately compacted areas.

END OF SECTION

SECTION 02512

SITE WATER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for potable water lines.

B. Valves for water service.

C. Double Check Backflow Preventers.

D. Yard Hydrants.

E. Fire Hydrants.

F. Disinfection and water line testing.

1.2 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching: for trenching, embedment, and backfill.

B. Section 02530 - Piping System Products: For water pipe materials.

C. Section 02535 - Piping Systems Installation

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. American Society for Testing and Materials (ASTM):
   1. F-477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

B. American Water Works Association (AWWA):
   1. C509 Resilient Seated Gate Valves 3 in through 12 in NPS, for Water and Sewage Systems.
   2. C550 Protective Epoxy Interior Coatings for Valves and Hydrants.
   3. C651 Disinfecting Water Mains.

C. Underwriters' Laboratories (UL):
   1. 246 Hydrants for Fire - Protection Service.

1.4 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Section 01300 - Submittals and Section 1700 - Contract Closeout:

A. Product Data for Review:
   1. Valve, materials, and details.
   2. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.
   3. Pressure gauge certification and calibration data.

B. Manufacturer’s Certificates: Contractor shall furnish the following prior to shipment:
   1. Affidavit of compliance with applicable standard.
   2. Test certificates.

C. Manufacturer’s Installation Instructions: Indicate special procedures required to install products specified.

1.5 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 01700 - Contract Closeout.

B. Record location of pipe runs, valves, connections, and elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable codes and ordinances for disposal of debris and burning of debris on site.

B. Contractor shall notify utility companies prior to commencement of construction and coordinate work with utilities as required.

1.7 QUALITY ASSURANCE

A. Manufacturer's name and pressure rating marked on valve body.

PART 2 PRODUCTS

2.1 PIPE MATERIALS: Covered under Section 02530 - Piping Systems Products.

2.2 VALVES

A. Gate Valves: All valves in the water system shall be gate valves.
   1. All gate valves size 3 inches and larger shall be iron body, resilient-seated, “O” ring type packing, disc gate valves for a working pressure of 175 psi, and tested on the shell to a hydrostatic pressure of 300 psi. The valves shall comply with the latest standard of AWWA C509. They shall be of the non-rising bronze stem type with square operating nut and shall have mechanical joint ends or hub ends. Valves shall be as manufactured by American, Clow, Mueller, or Engineer approved equal.
   2. All gate valves size 2-1/2 inches and smaller shall be Class 125 solid wedge type, of bronze construction with screwed bonnet, rising stem, and Teflon impregnated packing. Threaded end valves shall be Milwaukee “1148", Stockham “B-100", Walworth “Figure 55", or equal. Soldered end valves shall be Milwaukee “149", Stockham “B-108", Walworth “Figure 55SJ", or equal.
   3. Valve operation shall be clockwise to close and counter-clockwise to open.
   4. Wrenches: Valve wrenches shall be the standard wrenches manufactured by the valve manufacturer for operation of the valves. They shall fit snugly over the nuts and offer sufficient leverage for the easy operation of the valves and be constructed sufficiently strong for such usage. Valve wrenches shall be equipped with keys for the opening of valve boxes when such boxes are bolted. Two (2) valve wrenches shall be furnished with the valves without individual charge therefor.
   5. Valve Boxes: Valve boxes for all traffic areas shall be Clow F2452 (5-1/2" min. Inside diameter, slide type) or approved equal. Valve boxes for non-traffic areas shall be 6" ASTM D-2241 SDR-21 PVC pipe. The 6" PVC will extend to grade and shall have a Clay

& Baily 2194 cover and 1108 lid, or equal. Valve boxes shall be installed as detailed on the Drawings.

2.3 DOUBLE CHECK BACKFLOW PREVENTERS

A. Double Check Backflow Preventers shall have modular construction with union connections and renewable seats. Double check backflow preventers shall be Watts “Series 007", or equal. Size shall be as indicated on the Drawings.

2.4 YARD HYDRANTS

A. Yard Hydrants shall be the nonfreeze post type with bronze casing, sized for 48 inch bury depth. Three handle keys shall be provided. Yard hydrants shall be Josam “71701-1/2", Wade “W-8610", Zurn “Z-1390", or equal. Size shall be as indicated on the Drawings, 1-½” size where not indicated.

2.5 CONCRETE MATERIALS

A. Concrete used for thrust restraints shall be 4000 psi concrete, as specified in Section 03300 - Miscellaneous Concrete.

PART 3 EXECUTION

3.1 PREPARATION

A. All pipe, fittings, hydrants and accessories shall be loaded, unloaded, handled and stored in such a manner to ensure installation of sound and undamaged materials. Any pipe whose coating or cement lining has been damaged, broken, or loosened shall be repaired or replaced at the Contractor's expense prior to installation. Hooks shall not be used. Under no circumstances shall pipe, fitting, hydrants, or accessories be dropped or dumped.

B. The interior of all pipe, valves, fittings, and accessories shall be thoroughly cleaned of all foreign matter prior to installation and shall be kept clean until accepted by the Owner.

3.2 TRENCHING AND BACKFILL

A. All water main excavation shall be open cut unless otherwise indicated. Excavation and Trenching, including pipe embedment material, shall be as specified in Section 02320 - Earthwork and Trenching. Trench backfill and compaction shall be as specified in Section 02320 - Earthwork and Trenching.

3.3 PIPE INSTALLATION: Pipe installation is covered under Section 02535 - Piping Systems Installation. Additional requirements are specified herein.

A. Pipe shall be kept clean throughout installation. If dirt and debris enters the pipe, it shall be removed and the interior of the pipe swabbed with a 1 percent hypochlorite disinfection solution. At the end of each working day, a temporary watertight plug shall be installed at the termination of the water line.

3.4 VALVE INSTALLATION

A. All valves and fittings shall be cleaned and inspected prior to installation. Valves shall be opened and closed to ensure all parts are in good working condition.

B. Gate valves shall be set vertical in the horizontal pipeline. Valves and pipe shall be supported in such a manner to prevent stress to either component without deflection in the joint. Valves in plastic lines shall be braces securely with bricks to the satisfaction of the Engineer.

C. Valve boxes and lids shall be installed with each buried valve according to the details on the drawings centered and plumb over the operating nut so that the valve wrench engages easily. The valve box shafts shall be installed in such a manner to not transmit shock or stress to the valve.

D. The valve lids shall be set to subgrade or rough grading elevation at the time of installation and adjusted to finished grade at the completion of the project.

3.5 YARD HYDRANT INSTALLATION

A. Yard hydrants shall be installed plumb and according to the details on the Drawings.

B. At least one cubic foot of clean gravel or crushed rock shall be installed below each hydrant to allow drainage.

3.6 HYDROSTATIC TESTING

A. Hydrostatic pressure and leakage testing shall be conducted simultaneously and shall be performed in accordance with AWWA C600. The Contractor shall supply all tools, equipment and pipe necessary to perform the tests. The Engineer shall be notified a minimum of 24 hours prior to testing. Not more than 4000 feet of water line shall be installed without testing.

B. The hydrostatic pressure during testing shall be at least 150 percent (150%) of the normal operating pressure or a minimum of 100 psi. The duration of the test shall be at least two (2) hours.

C. The leakage test shall be performed concurrently with the hydrostatic pressure test. The water line is acceptable if the leakage does not exceed the allowable limits determined by the following formula:

$$Q = \frac{LD\sqrt{P}}{133{,}200}$$

Q = Allowable leakage, in gallons per hour
L = Length of pipe tested, in feet
D = Nominal pipe diameter, in inches
P = Average test pressure during leakage test, in psi

1. All visible leaks at exposed joints and all leaks evident on the surface shall be repaired regardless of the total leakage as shown by the test.

D. Water lines which fail to meet the test standards shall be repaired and retested at the Contractor's expense until the test requirements are met.

3.7 DOUBLE CHECK BACKFLOW PREVENTER TESTING: Double check backflow preventers shall be tested and certified under the following standards for double check backflow preventers: A.S.S.E. Std. No. 1015, AWWA Std. No. C510, FCCCHR of USC manual, Section 10, IAPMO listed.

3.8 WATER LINE DISINFECTION: Water line disinfection shall take place after hydrostatic testing has been performed successfully.

A. Water line disinfection shall be performed in accordance with AWWA C651. Not more than 4000 feet of water main shall be installed without disinfecting. All branches of the water system downstream of the point of connection with the site water main, including service to all buildings, shall be flushed and disinfected as specified herein. The Engineer shall be notified a minimum of 24 hours prior to disinfection.

B. After installation the entire waterline shall be completely filled and flushed to eliminate air and remove any foreign material in the line.

C. The Contractor shall chlorinate the line by the "continuous-feed method" or "slug-method" according to AWWA C651. Operate all valves and hydrants in order to disinfect appurtenances.

D. After the appropriate retention period has elapsed, the chlorinated water shall be flushed from the water line until the chlorine measurements of the water leaving the tested line are no higher than that of the existing system. Test water flushed from the line shall be disposed of in an environmentally safe manner and shall not be discharged into the sanitary sewer or the wastewater facility treatment processes.

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SECTION 02530

PIPING SYSTEM PRODUCTS

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall furnish all required piping, fittings, and all accessories for complete and functional piping systems as shown on the Drawings and specified herein.

B. Section Includes:
1. Piping materials for water distribution piping, sanitary sewer piping, piping outside of buildings, and other services.
2. Pipe fitting and accessories.

C. This section does not cover piping installation. See Section 02535 - Piping Systems Installation

1.2 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching: For trenching, embedment, and backfill.

B. Section 02512 - Site Water Lines

C. Section 02535 - Piping Systems Installation: For installation of products specified herein.

D. Section 02605 - Precast Manholes and Vaults

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. American Society for Testing Materials (ASTM):
1. A-193 - Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
2. A-194 - Specification for Carbon and Alloy Steel nuts for bolts for High-Pressure and High-Temperature Service.
3. A-194 - Specification for Carbon and Alloy Steel nuts for bolts for High-Pressure and High-Temperature.
4. B-88 - Specification for Seamless Copper Water Pipe.
5. D-1784 - Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds.
6. D-1785 - Poly (Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, 120.
7. D-2241 - Poly (Vinyl Chloride) Pressure-Rated Pipe (SDR Series).
8. D-2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
9. D-2464 - Threaded Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80.
10. D-2467 - Socket-type Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80.
11. D-2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
12. D-2837 - Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials.
13. D-3034 - Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
14. D-3139 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
15. D-3212 - Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals.
16. F-405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings

17. F-437 Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
18. F-439 Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
19. F-441/F-441M Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
20. F-493 Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
21. F-477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
22. F-606 - Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators and Rivets.
23. F-679 - Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
24. F-1970 Standard Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems.

B. American National Standards Institute (ANSI)/American Water Works Association (AWWA):
1. C104/A21.4 - Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
2. C105/A21.5 - Polyethylene Encasement for Ductile Iron Pipe Systems.
3. C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3 In. through 48 In.
4. C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
5. C115/A21.15 - Flanged Ductile Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
6. C150/A21.50 - Thickness Design of Ductile Iron Pipe.
7. C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
8. C153/A21.53 - Ductile Iron Compact Fittings 3 In. through 24 In. and 54 In. through 64 In. for Water Service.

C. American Water Works Association (AWWA):
1. C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. for Water Distribution.
2. C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. for Water Transmission and Distribution.

D. Uni-Bell PVC Pipe Association:

E. Uni-B-13-92 - Uni-Bell PVC Pipe Association Recommended Performance Specification for Joint Restraint Devices for Use With Polyvinyl Chloride (PVC) Pipe.

1.4 DEFINITIONS

A. Embedment: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Section 01300 - Submittals.

A. Product Data for Review:
1. Pipe and joint materials and details.
2. Details and materials of fittings, pipe accessories, and specials.
3. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.
4. Pressure gauge certification and calibration data.

B. Manufacturer's Certificates: Contractor shall furnish the following prior to shipment:
   1. Affidavit of compliance with applicable standard.
   2. Test certificates.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.

1.6 PROJECT RECORD DOCUMENTS

A. Requirements for project record documents are covered under section 02535 - Piping Systems Installation.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. Notes on Materials: Each pipe material below is given an alphanumeric abbreviation shown in parentheses, which is shown on the Drawings to denote the applicable specified material for the given size and service.

B. Type PSM Polyvinyl Chloride Gravity Sewer Pipe and Fittings (SDR-35 PVC): Shall meet the requirements of ASTM D-1784 cell classification 12454-B for PVC compounds, and ASTM D-3034 for poly vinyl chloride (PVC) sewer pipe.
   1. Minimum wall thickness shall conform to Standard Dimension Ratio 35 (SDR 35), except for 4-inch diameter pipe which shall conform to SDR 26.
   2. The Contractor shall install the maximum pipe lengths manufactured by the supplier.
   3. Joints: Flexible gasketed joints for PVC pipe and fittings shall be compression type joints with the gasket confined in either the spigot or the bell end of the pipe. Rubber gasket rings shall be neoprene or other synthetic material and conform to ASTM D-3212 and ASTM F-477. Natural rubber gaskets will not be acceptable.
   4. Fittings: Fitting joints shall be bell and spigot with elastomeric gaskets conforming to ASTM D-3212,, unless indicated on the Drawings to be solvent cemented joints, in which case the joint shall conform to ASTM D-2855. Fittings shall not be used unless directed by the Engineer or indicated on the Drawings.

C. Polyvinyl Chloride Plastic Pressure Pipe, Joints, and Fittings (SDR 21 PVC or Class 200): Shall meet the requirements of ASTM D-1784 cell classification 12454-A or 12454-B for PVC compounds, and ASTM D-2241 for (PVC) pressure pipe.
   1. Minimum wall thickness shall conform to Dimension Ratio 21 for Class 200.
   2. The Contractor shall install the maximum pipe lengths manufactured by the supplier.
   3. Joints: Joints shall be push-on type with integral bell and spigot and elastomeric gaskets meeting the requirements of ASTM D-2122 and ASTM D-3139. An integral wall-thickened bell end or an integral sleeve-reinforced bell end will be acceptable. Rubber gasket rings shall be neoprene or other synthetic material and conform to ASTM F-477. Natural rubber gaskets will not be acceptable.
      a. Bell restraint clamps: Clamps for restraining bell and spigot joints shall consist of clamping rings and rods, and shall meet the requirement of Uni-B-13-92. Restraint devices shall be of ductile iron, ASTM A536, Grade 65-45-12, with connecting bolts of high strength, low alloy metal in accordance with ANSI/AWWA C111-A21.11. All ferrous metal surfaces shall be shop coated with an epoxy coating for corrosion resistance. Bell restraint clamps shall be Ford Meter Box "Series 1350 Uni-Flange Block Buster", Romac "Series 611", or approved equal.

4. Joints for wastewater forcemain piping shall be groove& spline coupling with o-rings (flexible elastomeric seal). This piping shall be Certa-Lok Yelomine as manufactured by CertainTeed or Engineer approved equal.
5. Thrust restraints shall be concrete thrust blocks where possible. Where blocks are not possible, Contractor may use bell restraint clamps.

D. Polyvinyl Chloride Plastic Pipe and Fittings (SCH 40 PVC): PVC piping shall meet the requirements of ASTM D-1784 cell classification 12454-B for PVC compounds, and ASTM D-1785 for Schedule 40 PVC pipe.
1. Fittings shall be solvent welded socket-type, in accordance with ASTM D-2467. Threaded fittings, in accordance with ASTM D-2464, shall be used only where indicated on the Drawings or specifically allowed by the Engineer.
2. Primer and solvent cement shall conform to ASTM F656 and ASTM D2564, respectively.
3. Flange adapters shall be socket-type solvent welded, with diameter and drilling conforming to ANSI/ASME B16.5, Class 150. Flange gaskets shall be full face, chemical resistant elastomeric material. Flange bolts shall be ASTM Grade B, galvanized or stainless steel.

E. Polyvinyl Chloride Plastic Pressure Pipe and Fittings (SCH 80 PVC): PVC pressure piping shall meet the requirements of ASTM D-1784 cell classification 12454-B for PVC compounds, and ASTM D-1785 for Schedule 80 PVC pipe.
1. Fittings shall be solvent welded socket-type, in accordance with ASTM D-2467. Threaded fittings, in accordance with ASTM D-2464, shall be used only where indicated on the Drawings or specifically allowed by the Engineer.
2. Primer and solvent cement shall conform to ASTM F656 and ASTM D2564, respectively.
3. Flange adapters shall be socket-type solvent welded, with diameter and drilling conforming to ANSI/ASME B16.5, Class 150. Flange gaskets shall be full face, chemical resistant elastomeric material. Flange bolts shall be ASTM Grade B, galvanized or stainless steel.

F. Polyvinyl Chloride Plastic AWWA Pressure Pipe and Fittings (C900 and C905 PVC): Shall meet the requirements of ASTM D-1784 cell classification 12454-A or 12454-B for PVC compounds, and ANSI/AWWA C900 and ANSI/AWWA C905 for poly vinyl chloride (PVC) pressure pipe.
1. Minimum wall thickness shall conform to Dimension Ratio 18, for Class 150, unless otherwise noted on the Drawings.
2. The Contractor shall install the maximum pipe lengths manufactured by the supplier.
3. Joints: Joints shall be push-on type with integral bell and spigot and elastomeric gaskets meeting the requirements of ASTM D-2122. An integral wall-thickened bell end or an integral sleeve-reinforced bell end will be acceptable. Rubber gasket rings shall be neoprene or other synthetic material and conform to ASTM F-477. Natural rubber gaskets shall not be acceptable.
    a. Bell restraint clamps: Clamps for restraining bell and spigot joints shall consist of clamping rings and rods, and shall meet the requirement of Uni-B-13-92. Restraint devices shall be of ductile iron, ASTM A536, Grade 65-45-12, with connecting bolts of high strength, low alloy metal in accordance with ANSI/AWWA C111-A21.11. All ferrous metal surfaces shall be shop coated with an epoxy coating for corrosion resistance. Bell restraint clamps shall be Ford Meter Box “Series 1350 Uni-Flange Block Buster”, Romac “Series 611”, or approved equal.
4. Fittings: Fittings shall be ductile iron compact mechanical joint fittings conforming to ANSI/AWWA C153/A21.53. Mechanical joint dimensions, gaskets, and bolts shall conform to ANSI/AWWA C111-A21.11. Fittings shall have a cement-mortar lining in accordance with ANSI/AWWA C104/A21.4, or a 25 mil polyethylene lining in accordance with ASTM D -1248. Outside coating shall be manufacturer’s standard asphaltic coating with a minimum thickness of 1 mil.

5. Fitting Restraint: Fittings shall provide joint restraint by one of the two following options. Fitting restraint devices shall meet the requirements of Uni-B-13-92 and shall be designed for the pressure rating of the pipe. All ferrous metal surfaces shall be shop coated with an epoxy coating for corrosion resistance.
    a. A clamping ring bolted to the mechanical joint bell through the follower gland. Clamping ring shall be Ford Meter Box "Series 1300 Uni-Flange Block Buster" or approved equal.
    b. A clamping follower gland which replaces the standard mechanical joint follower gland. Clamping follower gland shall be EBAA Iron "Series 2000PV", Romac "GripRing", or equal.

G. Ductile Iron Pipe (DIP):
1. Pipe: Ductile iron, meeting the requirements of ANSI/AWWA C151/A21.51. Pipe shall have a wall thickness conforming to the following:
    a. Flanged pipe and all pipe inside tanks or buildings: Special Thickness Class 53.
    b. Buried pipe: 12-inch and smaller, Pressure Class 350. Larger than 12-inch, Pressure Class 250.
2. Joint Types: Where types of joints in ductile iron piping are indicated on the Drawings, these shall govern. Where not indicated on the Drawings, the following types of joints shall be used: All joints for piping inside wetwells, vaults, exposed locations, and other locations indicated on the Drawings shall be either grooved end or flanged joints. Joints for buried piping shall be restrained mechanical joint for sections of pressure conduits requiring joint restraint, as specified in Section 02535 - Piping Systems Installation. Joints for concrete-encased piping shall be mechanical joint.
3. Joint Requirements:
    a. Grooved End Joints: Shall conform to ANSI/AWWA C606. Couplings shall be cast of ductile iron conforming to ASTM A-536. Bolts shall be steel conforming to ASTM A-183. For couplings located inside liquid containing areas, bolts and nuts shall be stainless steel conforming to ASTM A-193. Gaskets shall be synthetic rubber.
    b. Flanged Joints: Flanges shall be threaded-on, flat faced ductile iron, conforming to ANSI/AWWA C115/A21.15. Bolts shall be steel, ASTM A307. Nuts shall be ASTM A307 steel with ANSI/ASME B.18.2.2 heavy semi-finished pattern. Gaskets shall be full faced synthetic rubber, 1/8-inch thick, conforming to Appendix B of ANSI/AWWA C111/A21.11.
    c. Push-on Joints: Shall conform to ANSI/AWWA C111/A21.11. Push-on joint gaskets shall be neoprene or synthetic rubber.
    d. Mechanical Joints: Shall conform to ANSI/AWWA C111/A21.11. Mechanical joint gaskets shall be neoprene or synthetic rubber.
    e. Restrained Mechanical Joints: Restrained mechanical joints shall utilize a follower gland incorporating individually activated wedges, with a rated working pressure of 350 psi. The restraining gland shall be capable of full mechanical joint deflection during assembly, and flexibility shall be maintained after burial. Torque-limited twist-off nuts shall be used to ensure proper actuation of the restraining wedges. Restraining gland shall be coated with manufacturer's standard asphaltic coating. Restraining glands shall be EBAA Iron "Megalug Series 1100" or equal.
4. Fittings: Grooved end fittings shall conform to ANSI/AWWA C110/A21.10, 350 psi pressure rating. Flanged fittings shall conform to ANSI/AWWA C110/A21.10, 250 psi pressure rating. Mechanical joint fittings shall conform to ANSI/AWWA C110/A21.10, 350 psi pressure rating. Compact fittings conforming to ANSI/AWWA C153/A21.53 may be used in lieu of standard pattern mechanical joint fittings.
5. Taps: When ductile iron pipe is to be tapped, as indicated on the Drawings, a factory welded-on boss shall be provided, unless standard pattern mechanical joint fittings are specifically indicated on the Drawings.

6. Lining: All pipe and fittings shall be provided with cement-mortar lining conforming to ANSI/AWWA C104/A21.4, or a 25 mil polyethylene lining in accordance with ASTM D -1248. Asphaltic lining shall be provided for cement-mortar lined pipe. For 3-inch pipe, cement mortar lining shall be omitted.
   a. Ductile iron piping for air service shall be unlined.
7. Asphaltic Coating: Exterior surfaces of all pipe which is to be buried or completely concrete encased, including fittings, shall receive a shop applied one-mil thick asphaltic coating. Asphaltic coating shall conform to AWWA C115, AWWA C110, and AWWA C153, as applicable.
8. Shop primer: Exterior surfaces of all pipe and fittings to be located inside buildings or in exposed locations above grade outdoors, shall be blast cleaned to near-white metal per SSPC-SP10 and shop coated with a high solids alkyd-phenolic primer to a dry film thickness of 3.0 mils. Shop primer shall be Tnemec "Series 37H Chem-Prime H.S." or equal. Exterior surfaces of all pipe and fittings to be located inside wetwells, tanks or vaults, shall be blast-cleaned to near-white metal per SSPC-SP10, and shop primed with a high solids epoxy, Tnemec "Series 69 Hi-Build Exosoline II" or equal, to a dry film thickness of 3.0 mils.
9. Polyethylene Encasement: All pipe and fittings shall be provided with a minimum of one wrap of polyethylene encasement. Polyethylene tube for polyethylene encasement shall be seamless, ANSI/AWWA C105/A21.5.

H. High Density Polyethylene DR-PR Plastic Pipe (HDPE): Shall meet the requirements of ASTM F-714 The polyethylene material shall be classified as Type III, Grade P34. The polyethylene pipe shall meet the requirements of ASTM D-3350 for cell classification 345444-C.
1. Forcemain: Wall thickness shall conform to ASTM F-714 for SDR-9, minimum working pressure of 200 psi, ductile iron pipe size. Pipe shall be Phillips Driscopipe "1000 (PE3408)" or Engineer approved equal.
2. Joints: Joints in HDPE pipe, fittings, and adapters shall be thermally welded by butt fusion.
3. Fittings: HDPE fittings shall be fabricated of pipe with a wall thickness at least as thick as the adjacent pipe, or greater as required by AWWA C906. Mitered bends shall have a minimum of five segments for 90 degree bends, a minimum of three segments for 45 degree bends.
4. Flange Adapters: Flange adapters for connecting HDPE pipe to PVC pipe shall consist of a stub of polyethylene pipe which is integrally molded with a polyethylene flange. Minimum flange face thickness shall be 1.5 times the pipe wall thickness, and the flange diameter and drilling shall match that of the mated ductile iron flange. A flange gasket shall be used. A flange backer ring of ductile iron or stainless steel shall be used. Flange bolts shall be stainless steel.
5. Mechanical Joint Adapters: Flange adapters for connecting HDPE pipe to ductile iron pipe shall consist of a stub of polyethylene pipe which is integrally molded with a polyethylene retaining ridge which is designed to fit against a ductile iron pipe mechanical joint bell and gasket. A ductile iron follower gland shall be provided. Joint bolts shall be stainless steel

I. Steel Piping (GSP): Steel piping shall be, Schedule 40 with buttwelded fittings. Threaded fittings may be used for pipe sizes 3 inches and smaller. Piping shall be galvanized where indicated on the Drawings or designated "GSP".
1. Pipe: ASTM A-53 Type E or S, Grade A or B.
2. Threaded Fittings: Forged steel, ANSI B16.11, Class 3000.
3. Threaded Fittings (galvanized pipe only): Galvanized malleable iron conforming to ANSI/ASME B16.3, Class 150.
4. Buttwelded Fittings: ANSI/ASME B16.9, standard weight.
5. Flanges: ANSI/ASME B16.5 Class 150, flat face. Flange gaskets shall be full face, 1/8-inch thick, chemical resistant elastic material, suitable for 250EF temperature.
6. Shop primer: Exterior surfaces of all steel pipe and fittings shall be blast cleaned to near-white metal per SSPC-SP10, and shop coated with a high solids alkyd-phenolic

primer to a dry film thickness of 3.0 mils. Shop primer shall be Tnemec "Series 37H Chem-Prime H.S." or equal.

J. Steel Casing Pipe

1. Casing pipe shall be installed as indicated on the Drawings to provide for repair, removal, and replacement of the carrier pipe without interference to traffic or disturbance of the feature being crossed by the carrier pipe.
2. Casing pipe and joints shall be made of metal and of leak proof construction. Casings shall be capable of withstanding E-80 loading (including impact).
3. Steel pipe shall have minimum yield strength of 35,000 pounds per square inch.
4. All metallic casing pipes are to be designed for effective corrosion control, long service life and relatively free from routine servicing and maintenance. Corrosion control measures must include cathodic protection.
5. Cast iron may be used for casing. It shall conform to ANSI A21. The pipe shall be connected with mechanical-type joints. Plain-end pipe shall be connected with compression-type couplings. The strength of the cast iron pipe to sustain external loads shall be computed in accordance with the most current ANSI A21.1 "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."
6. Wall thickness designated for steel casing pipe for E-80 loading shall be as follows:

Nominal Diameter (inches)	Min. Thickness for Coated (inches)	Min Thickness for Non-Coated (inches)
14 and Under	0.188	0.188
16	0.219	0.281
18	0.250	0.312
20 and 22	0.281	0.344
24	0.312	0.375
26	0.344	0.406
28	0.375	0.438
30	0.406	0.469
32	0.438	0.500
34 and 36	0.469	0.531
38, 40 and 42	0.500	0.563
44 and 46	0.531	0.594
48	0.563	0.625
50	0.594	0.656
52	0.625	0.688
54	0.656	0.719
56 and 58	0.688	0.750
60	0.719	0.781
62	0.750	0.813
64	0.718	0.844
66 and 68	0.813	0.875
70	0.844	0.906
72	0.875	0.938

7. The inside diameter of the casing pipe shall be such that the carrier pipe can be removed without disturbing the casing. All joints or couplings, supports, insulators or centering devices for the carrier pipe shall be considered in the casing diameter.

K. Plastic Casing Pipe

1. Plastic casing pipe shall be used and installed as indicated on the Drawings to provide for repair, removal, and replacement of the carrier pipe without interference to traffic or disturbance of the feature being crossed by the carrier pipe.
2. Casing pipe and joints shall be of leak proof construction.
3. The inside diameter of the casing pipe shall be such that the carrier pipe can be removed without disturbing the casing. All joints or couplings, supports, insulators or centering devices for the carrier pipe shall be considered in the casing diameter.
4. Plastic casing pipe shall be of the same or better quality pipe as the carrier pipe.

2.2 PIPE ACCESSORIES

A. Banded Couplings: Banded couplings for gravity piping shall be synthetic rubber repair couplings with stainless steel clamping ring bands, BANDSEAL by Dickey, Fernco coupling or approved equal. Banded couplings shall be provided to transition between different materials and sizes as required.

B. Pipe grouting rings: Pipe grouting rings shall be synthetic rubber, with stainless steel take-up clamps. Ring and clamps shall meet or exceed the requirements of ASTM C-923. Grouting rings shall be matched to the outside diameter of the carrier pipe. Grouting rings shall be Press-Seal Gasket Corporation “WS Series WaterSTOP Grouting Rings” or approved equal.

C. Mechanical couplings: Mechanical couplings shall be gasketed, sleeve-type, sized to properly fit the pipes to joined, with steel or ductile iron middle ring, steel or ductile iron follower rings, and synthetic rubber gaskets. Gaskets shall be SBR, Buna-N, or EPDM. All ferrous metal surfaces shall be shop coated with an epoxy coating for corrosion resistance. All hardware shall be 300 series stainless steel. Mechanical couplings shall be Ford Meter Box “Style FC1, Style FC2A, Style FC3, or Style FC23”, Dresser “Style 38, Style 153, or Style 162”, Smith-Blair “441 or 411”, or equal.

D. Dismantling Couplings: Dismantling couplings shall consist of ANSI flanged spigot which telescopes within a ANSI flanged adaptor to provide at least 1.5” of longitudinal adjustment. Spigot piece shall be ASTM A-283 Grade C steel. Flange adaptor shall be ASTM A-536 Grade 65-45-13 ductile iron. Tie bars shall be tensile steel. Gaskets shall be EPDM suitable for sewage. Tie bars, nuts, and washers shall be zinc coated. Flange adaptor and flange spigot shall be coated with a thermoplastic polymer coating, Rilsan “Nylon 11” to a thickness of 12 mils. Dismantling couplings shall be Viking-Johnson “Dismantling Joints” or approved equal.

E. Flange Adapters: Flange adapters shall be the cast iron slip-on type retained by set screws. Flange body shall be ductile iron, ASTM A-536, Grade 65-45-12. Set screws shall be manufactured from AISI 4140 steel, heat treated to Rockwell C 42-50 and zinc plated. Set screws shall have break away torque heads. Flange adaptors shall conform to ANSI B16.1 for machining and drilling. Gaskets shall be standard mechanical joint gaskets, EPDM or Buna-N. All non-plated ferrous metal parts shall be shop primed with an epoxy primer, for finish painting in the field. Flange adaptors shall be Ford Meter Box Corporation “UNI-Flange Series 200” or equal.

F. Wall Pipes: Wall pipes shall be ductile iron, cast as a single piece or fabricated. Ends shall be plain end, mechanical joint, or flanged as indicated on the Drawings. Where wall pipes are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.

G. Wall/Floor Sleeve Assemblies:

1. Wall sleeves: Sleeves shall be either:
   a. HDPE thermoplastic with molded-in waterstop and reinforcing ribs. Nailer caps shall be provided for setting in forms. Thunderline Corp. “Model CS” or equal.

b. Fabricated from heavy-wall welded or seamless carbon steel pipe, with full circle waterstop continuously welded to sleeve. Sleeve shall fabricated to proper wall thickness, and hot dip galvanized after fabrication. Thunderline "Model WS" or equal.

2. Floor Sleeves: Shall be as specified above for galvanized steel wall sleeves.
3. Modular casing seal: Shall have black EPDM seal elements, composite seal plates, and 18-8 stainless steel bolts and nuts. The sizing and number of seal links shall be accurately sized to accommodate the pipe outside diameter and the sleeve inside diameter. Modular casing seals shall be Thunderline "Link Seal Model S" or equal.
4. In lieu of wall sleeve assemblies specified above, Contractor may also provide Omni-Sleeve wall sleeve assemblies.
5. Where wall sleeves are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.

H. Flexible Expansion Sleeves: Flexible expansion sleeves shall be synthetic butyl rubber. The body shall consist of fabric and various rubber compounds reinforced with steel rings. The cover shall be suitable for service conditions, formed from natural rubber or synthetics and coated with a Hypalon paint. All materials shall be suitable for temperatures up to 250° F for pressure and vacuum service. Flexible expansion sleeves shall be single arch configuration, Redflex "SL-50" or equal.

I. Arch Expansion Joints and Reducers: Arch expansion joints and reducers shall be Neoprene, Hypalon, or Buna-N. Joint shall allow 3/4-inch elongation. The tube shall be a leak-proof lining of natural rubber or synthetic. The body shall consist of fabric and various rubber compounds reinforced with steel rings. The cover shall be suitable for service conditions, suitable for 250°F, formed from natural rubber or synthetics and coated with a Hypalon paint. Flanges shall be made of duck and rubber construction and full-faced with 150 lb ANSI standard drilling. Standard or tapered reducing arch expansion joints shall be provided indicated on the Drawings.

J. Valves and Accessories:
1. Flap gate: Flap gate shall be heavy duty cast iron with flange back frame with 125 lb. ANSI standard drilling. Hinge pins and seat faces shall be bronze.
2. Gate valves: Gate valves shall be iron-body, resilient-seated, tight closure gate valves with non-rising stems, "O"-ring type packing, and complying with AWWA C509. The waterway of the valve in the fully open position shall be unobstructed. All buried gate valves shall be specifically designed for buried use and shall be equipped with mechanical joint ends. The gate valve wedge shall have Buna "N: or SBR rubber bond to both sides to form a double seal when the valve is closed. Buried valves shall be equipped with a 2" square operating nut and all exposed gate valves shall be equipped with handwheel or chain operators unless indicated otherwise on the drawings. All valves shall open counterclockwise. The valve interior and exterior shall be coated with epoxy paint standard with the valve manufacturer.
3. Valve extension stems: When the distance from grade to the top of the operating nut exceeds 3 feet, buried valves shall be provided with a valve stem extension as shown on the drawings. Two (2) 2" square valve wrench with 5' T-bar handle shall be furnished. Buried valve operators shall have valve position indicators.
4. Valve boxes and covers: Valve boxes shall be constructed using a length of 6 inch cast iron or PVC CLS 200 pipe, valve box base, cover and lid as shown on the drawings. Lids on wastewater lines shall be stamped "sewer".
5. Air release valve: Valve shall be installed in a meter pit as shown on the drawings. The gate valves shall be bronze, screwed, non-rising stem, 175 psi working pressure. The air release valve shall be APCO model 443 or Valmatic "VM-801", Crispin model US20 or Engineer approved equal. All piping shall be brass piping except the air outlet from the air release valve which shall be copper tubing. Meter pit cover shall have 20" lid, 7 ½" depth and be provided with opening key.

6. Check valves: Check valves shall be lever and spring operated type with flanged ends conforming to ANSI B16.1, Class 125. The check valve shall be suitable for operation in the position indicated with adjustable spring tension on valve operating lever. The check valve shall have a cast iron body, bronze mounted stainless steel hinge pin, rubber faced disc and bronze seat ring.

2.3 GRANULAR EMBEDMENT MATERIAL

A. Granular embedment material shall be as specified in Section 02320 - Earthwork and Trenching.

2.4 BACKFILL MATERIALS

A. Backfill materials shall be as specified in Section 02320 - Earthwork and Trenching.

2.5 TRACER WIRE

A. A tracer wire of 12 gauge TW copper shall be installed with all plastic mains. The tracer wire shall be installed in the trench with the plastic pipe as detailed on the Drawings.

PART 3 EXECUTION

3.1 Refer to Section 02535 - Piping Systems Installation

END OF SECTION

SECTION 02535

PIPING SYSTEM INSTALLATION

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall install all required piping, fittings, embedment materials, and all accessories for complete and functional piping systems as shown on the Drawings and specified herein.

1.2 SECTION INCLUDES

A. Installation of piping, fittings, and accessories.

B. Process piping/waterline acceptance testing.

1.3 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching: For trenching, embedment, and backfill.

B. Section 02530 - Piping System Products: For products installed herein.

C. Section 02605 - Precast Manholes and Vaults

1.4 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. American Society for Testing and Materials (ASTM):
1. D-2774 - Standard Practice For Underground Installation of Thermoplastic Pressure Piping
2. D-2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

B. American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):
1. B1.20.1

C. American Water Works Association (AWWA):
1. C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. for Water Distribution.
2. C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. for Water Transmission and Distribution.

D. Uni-Bell PVC Pipe Association:
1. Uni-B-13-92 - Uni-Bell PVC Pipe Association Recommended Performance Specification for Joint Restraint Devices for Use With Polyvinyl Chloride (PVC) Pipe.

E. American National Standards Institute (ANSI):
1. B31.1

F. American Public Works Association (APWA):
1. Section 2500 Sanitary Sewers

1.5 DEFINITIONS

A. Embedment: Fill placed under, beside, and directly over pipe prior to subsequent backfill operations.

1.6 SUBMITTALS

A. Submittals for piping system products are covered under Section 02530 - Piping System Products.

1.7 PROJECT RECORD DOCUMENTS

A. Record location of pipe runs, connections, and invert elevations.

B. Record type of pipe material installed.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.8 REGULATORY REQUIREMENTS

A. Conform to applicable codes and ordinances for disposal of debris.

B. Contractor shall notify utility companies prior to commencement of construction and coordinate work with utilities as required.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements and elevations are as indicated on the Drawings.

PART 2 PRODUCTS

2.1 Refer to Section 02530 - Piping System Products

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that the pipeline lines and grades are as shown on the Drawings.

3.2 PREPARATION

A. The Contractor shall verify the location and depth of all utilities prior to construction. Prior to commencement of work the Contractor shall notify all those companies which have facilities in the vicinity of the construction.

3.3 PROTECTION

A. Locate, identify, and protect utilities that remain, from damage. The Contractor shall make every reasonable effort to protect all existing utilities from damage. If any utility is damaged through the carelessness or neglectful actions of the Contractor, the utility shall be repaired by its owner at the Contractor's expense.

B. Relocation of an existing utility which is within the public right-of-way shall be performed by the respective utility owner at no cost to the Contractor. Relocation and protection of an existing utility which is within a utility easement shall be the responsibility of the Contractor.

C. Any private facilities damaged or disturbed by the Contractor's work shall be repaired by the Contractor prior to close of the working day. Repairs shall be made in a manner sufficient to restore utility service to that property.

D. Protect trees, plant growth, and features designated to remain as final landscaping.

E. Protect all property or lot corner pins and stakes from damage or displacement. If property or lot corner markers must be moved, they shall be properly referenced prior to removal and reset by the Contractor upon completion of the project.

F. Protect from damage or displacement all project benchmarks and existing structures within or adjacent to the construction limits that are not to be removed or demolished.

3.4 SEPARATION OF WATER AND SEWER UTILITIES

A. Sanitary Sewers: When potable water pipes and sanitary sewers are laid parallel to each other, the horizontal distance between them shall be not less than 10 ft (3.0 m). The distance shall be measured from edge to edge. The laying of water pipes and sanitary sewers shall be in separate trenches with undisturbed earth between them. In cases where it is not practical to maintain a 10 ft. (3.0 m) separation, either the waterline or the sanitary sewer line shall be constructed of mechanical joint pipe or cased in a continuous casing, be constructed of mechanical joint pipe, or be jointless or fusion welded pipe. Where possible, the waterline shall also be at such an elevation that the bottom of the waterline is at least 18 inches above the top of the sanitary sewer. Casing pipe must be a material that is approved for use as water main. The Engineer will consult with the Missouri Department of Natural Resources to consider equivalent protection by other methods.
   1. Sections of sanitary sewers laid parallel to potable water pipes shall have warning tape installed on the top of the sewer pipe that warns that the pipe is a sanitary sewer.
   2. When a water pipe and a sanitary sewer cross and the sewer is 2 ft (0.6 m) or more (clear space) below the water pipe, no special requirements or limitations are provided herein. At all other crossings, the Engineer will consult with the Missouri Department of Natural Resources to consider equivalent protection by other methods.
   3. Joints in the sewer pipe shall be located as far as practical from the intersected water main.

B. Sewer Manholes: No water pipe shall pass through or come in contact with any part of a sewer manhole.

C. Storm Sewers: The separation distance between a storm sewer (which is not a combined storm/sanitary sewer) and a water main, if encountered, shall be determined by the Engineer based on geotechnical considerations. Required separation distances between water mains and combined storm/sanitary sewers are equivalent to those for water mains and gravity sanitary sewers.

D. Drains: Underground drains from fire hydrants or valve pits should not be directly connected to sanitary or storm drains.

3.5 PIPE EMBEDMENT/ENCASEMENT

A. Material and installation for pipe embedment and concrete encasement shall be provided as indicated on the Drawings and specified in Section 02320 - Earthwork and Trenching.

3.6 PIPE INSTALLATION

A. All pipe shall be protected during transport, storage and installation from shock and free fall. Pipes shall be installed without cracking, chipping, breaking, bending or damaging the materials.

Damaged pipe shall be replaced with new materials except when repairs are permitted by the Engineer. Use slings, lifting lugs, hooks and other protection devices during handling.

B. Install pipe of the size, material, strength class, and joint type as specified or indicated on the Drawings. Every pipe fitting is not called out on the Drawings. Contractor shall provide fittings required to connect piping as shown on piping plans, and plan and profile Drawings. Additional fittings required to make vertical changes in elevation to avoid utilities or to meet connections shall be provided at no additional cost to Owner.

C. The maximum fitting bend for force mains and pressurized process piping shall be 45 degrees. When multiple fittings are assembled adjacent to make deflections in alignment, adequate piping shall be provided between for thrust restraint.

D. Where cutting of pipe is allowed, pipe shall be cut from measurements taken at the site and not from the Drawings.

E. Install gravity pipelines beginning with the lowest point of the pipeline and install pipe with the spigot or tongue end downstream. Install pressure pipelines with the bell ends facing the direction of laying, except when reverse laying is specifically authorized by the Engineer.

F. Install pipe to the line and grades indicated on the drawings. Unless otherwise noted on the Drawings, minimum cover over top of pipe shall be 42 inches. Maximum slope variation from true slope shall be one inch between structures for gravity sewers. The maximum variation from alignment between structures shall be two inches. Joint deflection shall not exceed the maximum allowable deflection per joint according to the governing standard. The pipe manufacturer's maximum recommended deflection limits, if more stringent, shall govern over the referenced standards.
   1. Only one correction for alignment and/or grade shall be made between structures.
   2. The Contractor shall establish such grade control devices necessary to maintain the specified tolerance. All pipe shall have a continuous slope free of depressions.

G. Pipe installation shall be in accordance with applicable standards, such as ASTM C-12, D-2321 and ANSI/AWWA C600, except where conflicts with this section occur, in which case this section shall govern.

H. Clean the interior of all pipe fittings and joints prior to installation. Protect pipe against the entrance of debris and foreign matter during discontinuance of installation and at the close of the working day by installing a close fitting plug at the open end. Plugs shall be water tight against heads up to 20 feet of water.

I. The Contractor shall take whatever means necessary to keep the trenches free of water and as dry as possible during pipe installation, bedding and jointing operations.

J. After each pipe has been brought to grade, aligned and placed in final position, place sufficient embedment material under the haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding and backfilling operations. Place embedment material uniformly and simultaneously on each side of the pipe to prevent lateral displacement. Embedment material shall be compacted as specified in Section 02320 - Earthwork and Trenching.

K. Pipe Jointing: Locate joints to provide for differential movement at changes in type of embedment, concrete collars and encasement and structures. Pipe jointing shall be according to the following specifications:
   1. Clean and lubricate all joint and gasket surfaces as recommended by the manufacturer.
   2. Examine all materials prior to installation for soundness and compliance with specifications.

3. Check joint position and condition after assembly prior to installing additional pipe sections.
4. Check joint opening and deflection for specification limits.

L. Pipe cutting shall be performed in a neat and workmanlike manner without damage to the pipe. Main taps for service saddle tees shall be made with a tapping tool specifically designed for that purpose. Cut edges shall be smoothed by power grinding to remove burrs and shape edges.

M. Pipe connection to structures: Pipe connection to new structures shall be as shown on the Drawings.

3.7 REQUIREMENTS FOR PIPE JOINTS: Pipe joints shall be carefully and neatly made, in accordance with the requirements which follow.

A. Threaded: Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be full and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs.
1. Threaded joints, in plastic piping, shall be made up with Teflon thread tape applied to all male threads. Threaded joints, in stainless steel piping, shall be made up with Teflon thread tape applied to all male threads. At the option of the Contractor, threaded joints in other piping may be made up with Teflon thread tape, thread sealer or a suitable joint compound.

B. Flared: Ends of annealed copper tubing shall be cut square, and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as required, to produce leak-tight connections.

C. Solvent Welded: All joint preparation, cutting and jointing operations shall comply with the pipe manufacturer's recommendations and ASTM D-2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Pressure testing, of solvent welded piping systems, shall not be performed until the applicable curing time, set forth in Table X2.1 of ASTM D-2855, has elapsed.

D. Flanged: Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly. Connecting flanges shall have similar facings, i.e., flat or raised face.

E. Welded: Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping", ANSI B31.1. The following requirements shall also apply for stainless steel piping:
1. High purity inert welding gases and cover gases shall be used. Weld surfaces shall be sliver, light gold or straw color at worst, after welding. Black welds are not acceptable.
2. Prior to welding, all surfaces shall be clean and free of all organic materials, moisture and dirt.
3. Welds shall be dressed using aluminum oxide grinding wheels. Silicon carbide is not acceptable.

F. Push-on: Gasket installation and other jointing operations shall be in accordance with the recommendations on the manufacturer. Each spigot end shall be suitable beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

G. Rubber Gasketed: When rubber-gasketed joints are used for hub and spigot type cast iron soil pipe, spigot ends shall be plain, without beads. Cut ends of all pipe shall be cut square and all burrs

removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast-iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

3.8 PLASTIC PRESSURE PIPE (PVC)

A. Pipe joints shall be assembled according to manufacturer's instructions. Joints shall be restrained with bell restrained clamps in locations where restrained joints are required, as specified herein.

B. Mechanical joint fittings shall be assembled as specified herein for ductile iron pipe.

3.9 JOINT RESTRAINT FOR PRESSURE PIPING: Joint restraint shall be provided for portions of buried piping which will serve in a pressure flow application, including: water lines and pump discharge lines.

A. Joint restraint for all pressure pipe shall be accomplished by means of thrust blocks, as shown and detailed on the Drawings.
   1. All plugs, caps, tees, bends and hydrants shall be provided with thrust blocks according to the details in the plans, and using 3,000 psi concrete.
   2. The concrete shall extend from the fitting or hydrant to undisturbed soil and poured or formed so that joints are accessible. If adequate soil support cannot be obtained, a mechanical restraining assembly shall be installed.

B. Where specifically indicated on the Drawings, concrete thrust blocks shall be provided in place of mechanical restraint.

C. Joint restraint for pressure pipe shall be accomplished using bell restraint clamps for joints between pipes, and fitting restraint devices at joints with fittings, as specified herein. Joints shall be restrained for a minimum distance as recommended by the manufacturer of the joint restraint device being used and for the conditions in which the pipe is installed.

3.10 DUCTILE IRON PIPING

A. Handling: Pipe and fittings shall be handled and installed carefully to prevent damage to pipe material, linings, and coatings. Hooks placed in ends of pipe or fittings shall have well-padded surfaces. All coatings which are damaged shall be repaired by the Contractor prior to installation, to the satisfaction of the Engineer.

B. Cutting: Pipe shall be shop fabricated to the approximate lengths required. Pipe shall not be cut in the field, except where flange adapters or mechanical couplings are indicated on the Drawings or where allowed by Engineer. Pipe may be cut with a portable saw, abrasive wheel, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be permitted. Cuts shall be smooth, straight, and at right angles to the pipe axis. Cut edges shall be dressed with a file or power grinder to remove all roughness and sharp edges.

C. Flanged Joints: Flange faces shall be machine faced with pipe end, flat and perpendicular to the pipe axis. When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting, which would cause unnecessary stress in the flanges. Bolts shall be tightened gradually and uniformly, to ensure uniform compression of the gasket. Flange faces shall have a minimum of 8-inches of separation to the nearest wall.

D. Mechanical Joints: Mechanical joints shall be assembled according to the manufacturer's recommendations. If the joint does not form an effective seal, the joint shall be completely disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Mechanical joints shall be restrained where specified herein.

E. Grooved End Joints: Grooved end joints shall be assembled according to the manufacturer's recommendations. If the joint does not form an effective seal, the joint shall be completely disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in the manufacturer's installation instructions, to ensure uniform compression of the gasket.

F. All buried ductile iron pipe shall be provided with polyethylene tube protection installed in accordance with AWWA C105, Method A.

3.11 HDPE PLASTIC PIPE

A. Thermally welded joints shall me made in accordance with the manufacturer’s recommendations. Pipe ends shall be properly cut, faced, heated, and joined to provide a tight and thoroughly fused joint with uniform bead thicknesses. The thickness of each bead on a finished joint shall be of uniform diameter.

3.12 REINFORCED CONCRETE PIPE (RCP) NOT USED

3.13 COPPER TUBING

A. Applications: Copper tubing for buried water service and for buried compressed air service shall be ASTM B88, Type K, annealed temper, in 100 ft. coils. Copper tubing exposed compressed air service shall be ASTM B88, Type K, drawn temper.

B. Installation:
1. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
2. Use fittings for all changes in direction and branch connections. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted unless expressly indicated. Where bedding is allowed by Engineer, use a mandril.
3. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
4. Install piping level with no pitch.
5. Pipe supports shall be spaced at a maximum of 5 foot intervals.

C. Brazed Joint Construction: Comply with the procedures contained in the AWS "Brazing Manual."
1. Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
2. Fill the tubing and fittings during soldering and brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints to proper and uniform temperature.

3.14 WELDED STEEL PIPE

A. All pipe welders performing work under this contract shall be qualified per Section IX of the ASME Code or the American Welding Society Standard AWS B3.0-77 "Welding Procedure and Performance Qualification."

B. Documentation of welding procedure specifications and welders' qualifications shall be submitted for approval.

C. Pressure piping shall be welded in accordance with ANSI B31.1.

D. All butt welds shall have full penetration and shall be smooth and uniform on the pipe interior.

E. Carbon steel welds shall be either gas tungsten arc welding or shielded metal arc welding on the root pass and completed by any of the acceptable metallic arc processes.

F. When welding low carbon grade stainless steel, low carbon electrodes or filler metal compatible to the base metal shall be used.

G. Fillet welds shall have complete penetration. Any cracks, holes, slag or lack of fusion appearing on the weld surface shall be removed before depositing the next layer.

3.15 DIRECTIONALLY DRILLED CROSSINGS

A. Directionally drilled crossings shall be performed in accordance with industry practice, and shall include all labor, equipment and consumables necessary to accomplish the following:
1. Clearing, grading, and general site/access preparation necessary for construction operations;
2. Transportation of all equipment, labor, consumables, and Owner supplied materials to and from the jobsite;
3. Erection of horizontal drilling equipment at the drill site;
4. Reaming the pilot holes to a diameter suitable for installation of the prefabricated pull sections;
5. Installation of the prefabricated pull sections along the reamed holes;
6. Fabrication of the pull sections; and
7. Clean-up and restoration of all work areas.

B. Horizontal directional drilling type machines shall be used when a minimum bend radius is specified on the project "Drawings". Contractor shall not bore a radius smaller than specified on the project "Drawings". Wash boring is not permitted.

C. Sodium Bentonite and/or gel type drilling muds are permitted for cuttings removal, borehole stabilization and carrier pipe lubrication on pullback.
1. No fluid shall be approved or used that does not comply with permit requirements and environmental regulations.
2. Disposal of drilling fluids shall be the responsibility of the Contractor and shall be conducted in compliance with all relative environmental regulations, right-of-way and workspace agreements, and permit requirements.
3. Mud pits shall be suitably lined and bermed to prevent leakage to the surrounding area. All barrels, tanks, connections, valves, lines, etc. shall be maintained in good condition so that leaks do not occur. Should a leak occur, any spillage shall be cleaned up immediately and the cause of the leak remedied.
4. The drilling Contractor shall be responsible for mud containment/disposal.
5. The Contractor is responsible for securing permits and transporting all excess fluids to an approved disposal site.

D. Pulling:
1. Before inserting a plastic pipe through a bored hole, ensure that the size of the bore is of sufficient diameter to prevent stress during insertion.
2. The pull section shall be supported during pull back so that it moves freely.
3. A swivel shall be used to connect the pipeline pull section to the reaming assembly to minimize torsional stress on the pipeline pull section.
4. A leader or fuse link approximately four feet long of the next smaller size PE pipe shall be added to the pulling hitch.
5. The pull section shall be installed in 1 continuous length with no tie-in welds, if possible. If this is not possible, tie-in welds shall be minimized.
6. The leading end of the inserted pipe shall be closed to prevent entrance of dirt and water.
7. After insertion, the leading end shall be examined in the exit bell hole to see if there are any scratches or gouges which would indicate contact with sharp objects.

8. If the pipe is damaged or distorted, remove the pipe and pull a plug through the bore to clean the hole. Repeat this process as many times as necessary until the leader passes through the bore undamaged.
9. The maximum allowable pulling force on the pipeline pull section shall not exceed 5,500 pounds.
10. The Contractor shall at all times provide and maintain instrumentation which will accurately locate the pilot hole and measure drilling fluid flow discharge rate and pressure. The Owner shall have access to these instruments and their readings at all times.
11. Polyethylene has elastic properties, and if the pulling load on the pipe does not exceed the Safe Pull Strength, the pipe will relax back to its original pre-pull length. After the pull is complete, a relaxation period of several hours is necessary before final tie-in. The pipe shall be pulled slightly past the tie-in point to accommodate pipe contraction and facilitate final tie-in.

E. Tracer Wire: In an "uncased" insertion of plastic pipe through a bored hole, a 12-gage copper tracer wire shall be attached to the leading pipe and inserted along with the pipe. Care shall be used to try and minimize the twisting of the wire around the pipe.

3.16 CASING PIPE INSTALLATION

A. Casing and pipeline installations should be accomplished by directional boring, jack-and-bore, tunneling or other approved methods. Tunneling construction under railroad tracks will be permitted only under direct supervision of the owner of the railroad. Generally, tunneling shall not be considered where less than six (6) feet of cover exists, or where excessively sandy, loose or rocky soils are anticipated.
1. For cased crossings of railroads:
a. Tunneling procedures and equipment, as well as structural design, must have the railroad owner=s approval prior to starting any work on railroad property.
b. Rail elevations over the work must be monitored at intervals prescribed by the railroad to detect any track movement. Movements of over one-quarter (1/4) inch vertically shall be immediately reported to the Railroad=s designated representative. Due to the danger to rail traffic that is caused by only small amounts of track movements, the Railroad may have to be called to surface the track several times.
2. The following requirements shall apply to the above construction methods:
a. The use of water under pressure jetting or puddling will not be permitted to facilitate boring, pushing or jacking operations. Some boring may require water to lubricate cutter and pipe, under such conditions, is considered dry boring.
b. Where unstable soil conditions exist, boring or tunneling operations shall be conducted in such a manner as not to be detrimental to the roadway or railroad being crossed.
c. If excessive voids or too large a bored hole is produced during casing or pipeline installations, or if it is necessary to abandon a bored or tunneled hole, prompt remedial action should be taken by the Contractor.
d. All voids or abandoned holes caused by boring or jacking are to be filled by pressure grouting. The grout material should be sand cement slurry with a minimum of two (2) sacks of cement per cubic yard and a minimum of water to assure satisfactory placement.
e. The hole diameter resulting from bored or tunneled installations shall not exceed the outside diameter of the utility pipe, cable casing (including coating) by more than one and one-half (1-1/2) inches for pipes with an inside diameter of twelve (12) inches or less, or two (2) inches on pipes with an inside diameter greater than twelve (12) inches.

B. Vents. In casing pipe installations, vents are appurtenances by which fluids or gases between carrier and casing may be inspected, sampled, exhausted or evacuated.

1. Vents shall be located at the high end of short casings and at both ends of casing longer than one hundred fifty (150) feet.
2. Vent standpipes shall be located and constructed so as not to interfere with maintenance of the roadway or railroad, or to be concealed by vegetation. Where possible, they shall be marked and located at the property line. The markers shall give the name and address of the owner, and a phone number to contact in case of emergency.
3. Casing pipe, when sealed, shall be properly vented. Vent pipes shall be of sufficient diameter, but in no case less than two (2) inches in diameter and shall be attached near each end of casing, projecting through ground surface at property lines.
4. Vent pipes shall extend not less than four (4) feet above ground surface. Top of vent pipes shall be fitted with a down-turned elbow, properly screened; or a relief valve.
5. For pipelines carrying flammable materials, vent pipes on casings shall be at least 16 feet (vertically) from aerial electric wires. Casings shall be suitably insulated from underground conduits carrying electric wires on roadway or railroad right-of-way.

3.17 PIPE ACCESSORIES

A. Mechanical couplings: Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations. Pipe ends shall be separated by a space of at least 1/4 inch but not more than 1 inch. Pipe and coupling surfaces which contact gaskets shall be clean and free from dirt during assembly. Following installation of the coupling, damaged areas of shop coatings on the pipe and couplings shall be repaired.

B. Flange Adapters: Flanged coupling adapters shall have cast iron/ductile iron body and follower, and synthetic rubber gasket. Body shall have anchor studs or locking pins. Surfaces shall be shop primed for field painting. Flanged coupling adapters shall be Dresser “Style 127" or Smith-Blair “Type 912" or Romac Style FCA501 or approved equal.

C. Wall Pipes: Where wall pipes with flanged or mechanical joint ends are installed, the bolt holes in the bell of the wall pipe shall straddle the top centerline of the casting. The top centerline shall be marked on the wall pipe at the foundry.

3.18 GRAVITY PIPING ACCEPTANCE TESTING

A. All new segments of sewer or other gravity piping between manholes or structures will be subject to acceptance testing under this subpart. Segments of piping which are shorter than 100 feet will not be subject to testing.

B. Visual Inspection:
1. Clean pipe of excess mortar, joint sealant, dirt and debris prior to inspection.
2. Inspect the sewer by lamping the pipeline between manholes to determine the location of any misaligned, displaced or broken pipe and any visible infiltration or defects. In large pipes where space permits, the visual inspection may be made by physical passage.
3. Correct defects as required prior to conducting leakage tests.

C. Air Leakage Test:
1. Contractor shall perform air leakage tests for all pipe sizes.
2. Notification: Contractor shall notify Engineer at least 48 hours in advance the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.
3. Contractor shall provide all necessary equipment for performance of the air leakage test, including but not limited to piping connections, pipe plugs with taps, test pumping equipment, pressure gauges, bulkheads and regulators to avoid over pressurization. The equipment and gauges shall meet the minimum specifications set forth in ASTM F-1417. The air equipment shall consist of necessary valves and pressure gauges to control an

oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.

4. Gauge certification from the manufacturer and calibration data shall be required for all pressure test gauges, a copy of which will be made available to the Engineer at the time the air tests are performed.
5. Test each reach of pipe between manholes after completion of pipe and appurtenance installation and trench backfill.
6. Plug ends of sewer line at manholes and cap or plug all lateral connections to withstand internal pressure. One plug shall have two taps for connecting equipment. After connecting air control equipment to the air hose, begin increasing the air supply within the pipe section, monitoring the air pressure so that the internal pressure does not exceed 6.0 psig.
7. After the internal pressure reaches 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two minutes in order to reach equilibrium between air temperature and pipe walls. During this time, check all plugs for leaks. If leaks are found, bleed off air, tighten plugs and begin increasing the air supply again.
8. Air testing shall take place by the Time-Pressure Drop Method. Decrease the pressure to 3.5 psig and begin timing to determine the time required to achieve a pressure drop from 3.5 to 2.5 psig. If the time, in seconds, to achieve the 1.0 psig pressure drop is greater than that shown in the following table, the line is presumed free of defects. For pipe sizes and lengths other than those shown in the table below, refer to ASTM F-1417.

Required Time for Length up to Length Indicated, min:sec

Pipe Size	up to 100 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
8"	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10"	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12"	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15"	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18"	17:00	25:38	32:03	38:37	44:52	51:16	57:41
21"	19:50	34:54	43:37	52:21	61:00	69:48	78:31
24"	22:47	45:34	56:38	68:22	79:46	91:10	102:23
27"	28:51	57:41	72:07	86:32	100:57	115:22	129:48

9. If the air test fails to meet the requirements, repair the defects and retest the line. All constructed sewer lines shall pass the low pressure air test prior to acceptance.
10. In areas where ground water is known to exist, a 2-inch diameter, 10 inch long, capped pipe nipple shall be installed at the top of the pipe through the manhole wall during installation. Immediately prior to performing the acceptance test, the ground water level shall be determined by connecting a clear plastic tube into the nipple and holding vertically until the water level stops rising. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to the test readings.
11. Reinforced Concrete Pipe shall be air tested in accordance with ASTM C924 - Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.

D. Deflection Test for Flexible Sewer Pipe:

1. Prior to final acceptance, the Contractor shall perform a diametral deflection test on all flexible and semi-flexible pipe (such as PVC plastic pipe). Tests shall be conducted between manholes or structures. Deflection testing of a segment of sewer shall occur at least 30 days after the pipe has been installed and completely backfilled.
2. The maximum allowable deflection shall be five percent of the inside pipe diameter. A mandrel with a diameter equal to 95 percent of the inside diameter of the pipe to be tested shall be used. Any section of sewer failing the diametral deflection test shall be repaired or replaced by the Contractor at no cost to the Owner, and retested.

3.19 PRESSURE PIPING ACCEPTANCE TESTING

A. All new pressure piping will be subject to hydrostatic pressure testing under this subpart. Force mains and pressure sewers shall be tested from the point of discharge to the isolation valves in the corresponding lift station(s). New segments of pipelines which will be connected to existing lines shall be pressure tested prior to connection.

B. Water lines, including potable water and service water, shall be tested in accordance with Section 02512 – Site Water Systems, and shall be disinfected after hydrostatic testing in accordance with AWWA C651 and Section 02512 – Site Water Systems.

C. Notification: Contractor shall notify Engineer at least 48 hours in advance of the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.

D. Test Conditions:
   1. Test pressure shall be 100 psi (gauge) for the sewage forcemain, for process piping and for other pressure pipes. This pressure will not exceed the thrust-restraint design pressure.
   2. The hydrostatic test shall be of at least a 2 hour duration. Test pressure shall not vary by more than ∀5 psi for the duration of the test.
   3. Contractor shall pressure test new forcemain in segments or increments not to exceed 3,000 feet.
   4. If Contractor chooses to test in segments, provide AWWA resilient seated gate valves or temporary valves.

E. Test materials: Contractor shall supply all of the necessary plugs, hose, riser pipe, pumps, gauges, and other equipment as required for the testing. The Contractor shall obtain permission from the Owner for use of Owner's water supply from an existing fire hydrant.

F. Pressurization: After the pipe has been laid and backfilled, the section of pipe shall be isolated. The pipe shall be slowly filled with water. Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place as directed by the Engineer. The specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied by means of a pump connected to the pipe. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. The system will be allowed to stabilize at the test pressure before the leakage test is conducted.

G. Examination: All exposed pipe, fittings, valves, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until satisfactory results are obtained.

H. Leakage: Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time. Allowable leakage shall be as follows:

Pipe Size (inches)	Allowable Loss 50 psig test pressure (gallons per hour per 1,000 feet)	Allowable Loss 100 psig test pressure (gallons per hour per 1,000 feet)
1.5	0.080	-
2	0.106	-
4	0.212	0.30
6	0.319	0.45
8	0.425	0.60
10	0.531	0.75
12	0.637	0.90
14	0.743	1.05
16	0.849	1.20
18	0.956	1.35
20	1.063	1.50

I. Acceptance of Installation: Acceptance shall be determined on the basis of allowable leakage. If any test of pipe discloses leakage greater than that specified above, repairs or replacements shall be accomplished in accordance with the specifications. All visible leaks shall be repaired regardless of the amount of leakage.

3.20 AIR PIPE ACCEPTANCE TESTING NOT USED

3.21 FIELD QUALITY CONTROL

A. Perform field inspection and testing.

B. Compaction and soil testing will be performed in accordance with Section 02320 - Earthwork and Trenching.

END OF SECTION

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SECTION 02536

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 DESCRIPTION

A. Section includes requirements for Horizontal Directional Drilling (HDD) of High-Density Polyethylene (HDPE) Pressure pipe.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, tools, and equipment required to install a new forcemain using the directional drilling method to the sizes and limits as shown on the plans, and as specified by these technical specifications herein. Work includes, but not limited to, proper installation, testing, restoration of underground utilities and environmental protection and restoration.

B. The directional drilling method involves first drilling a pilot hole as shown on the approved pilot bore plan, and then enlarging the pilot hole no larger than 1.5 times the outer diameter of the pull-in pipe, pipe joint or coupling and pull back the pipe through the enlarged hole.

1.3 QUALITY ASSURANCE

A. Experience: Actively engaged in horizontal directional drilling for minimum of 3 years.

B. Field supervisory personnel: Experienced in the performance of the work and tasks as stated herein for minimum of 3 years.

1.4 SUBMITTALS

A. Submit for information only.
   1. Presentation of similar experience in the last 3 years.
   2. Include, but not limited to, owner name, address, telephone number, contact person, date and duration of work, location, pipe information, and contents handled by pipeline.
   3. Supervisory field personnel and historical information of HDD experience.
      a. At least one field supervisors listed must be at site when HDD operations are in progress.

B. Submit following Section 01300.
   1. Working Drawings and written procedure describing in detail proposed method and entire operation for information only including, but not limited to:
      a. Size, capacity and arrangement of equipment.
      b. Location and size of drilling and receiving pits.
      c. Dewatering and methods of removing spoils material.
      d. Method of installing detection wire and pipe.
      e. Type, location and method of installing locator station.
      f. Method of fusion pipe segment and type of equipment.
      g. Type of cutting head.
      h. Method of monitoring and controlling line and grade.
      i. Detection of surface movement.
      j. Bentonite drilling mud for information only:
         1) Products information, material specifications, and handling procedures.
         2) Material safety data sheet and special precautions required.
         3) Method of mixing and application.

1.5 PROJECT CONDITIONS

A. Complete HDD so as not to interfere with, interrupt, or endanger surface and activity thereon.

B. Do not use HDD in rock stratum or subsoil consisting of boulders and underground obstructions that impede the process.

1.6 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching.

B. Section 02530 - Piping System Products.

C. Section 02535 - Piping Systems Installation.

D. Section 02605 - Precast Manholes and Vaults.

1.7 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. American National Standards Institute (ANSI):
   1. A10.16 - Safety Requirements for Tunnels, Shafts, and Caissons.

PART 2 PRODUCTS

2.1 MATERIALS

A. PIPE: Pipe shall be as called out on the Drawings and as specified in Section 02530. Pipe joints shall be installed in accordance with Section 02535.

B. Drilling Fluid.
   1. Bentonite drilling mud compatible with the environment.
   2. Waste oil or environmentally non-compatible polymers cannot be part of composition.

C. Detection Wire: TW, THW, THWN, or HMWPE insulated copper, 10 gage or thicker wire.

D. Locator Station.
   1. Underground, Flush Mounted:
      a. Tube minimum 15 inches long with minimum inside diameter of 2-1/2-inches made of non-corrosive material, schedule 40 PVC, HDPE, or equal.
      b. Factory attached cast iron or high-impact plastic collar with ribs to prevent rotation when removing locking lid after locator station is set in concrete.
      c. Light blue cast iron or high-impact plastic locking lid that will withstand AASHTO H-20 traffic loads and ultra-violet rays.
      d. Mark locking lid to identify pipeline with a permanent identification such as P.S. Locator.
      e. Terminal block made of high dielectric material, which is made of phenolic resin, plastic, micarta, Lexan or Bakelite for each locator station.
         1) Terminal block furnished with two 3/16-inch threaded studs, nuts, and washers made of nickel-plated brass.
      f. Approved manufacturers:

1) C.P. Test Services, Inc., Model Mini.
2) Handly, Industries, Model T2IS2.
3) Approved equal.

2. Manhole Mounted:
   a. Waterproof enclosure made from cast aluminum, galvanized steel, high-impact plastic, Lexan, Gyrlyn, or equal.
   b. Light blue schedule 40 PVC pipe or schedule 40 galvanized steel with outside diameter of at least 3/4-inch to mount enclosure.
   c. Use similar materials for pipe and enclosure to fasten enclosure onto pipe following manufacturer's instructions.
   d. Approved manufacturers:
      1) Cott Manufacturing Company, Model Finklet or Finkplate, 2 leads.
      2) Gerome Manufacturing Company, Inc., Model Testox Series 300, 2 leads.
      3) Approved equal.

PART 3 EXECUTION

3.1 PREPARATION

A. Excavate pits following working drawings and Section 02320.

B. Provide equipment to guard against electrocution and an alarm system on drilling equipment capable of detecting electrical current as it approaches electric lines.

C. Test pit underground utilities crossing before HDD operation.

3.2 OPERATION

A. General.
   1. Determine drilling length and equipment pull strength for type of soil encountered.
   2. Provide method to control line and grade.
      a. Provide and maintain instrumentation that accurately locates pilot hole.
      b. Drill pilot hole along path following Drawings to these tolerances:
         1) Vertical alignment plus or minus 0.5 foot. Vertical path of the pilot hole must not establish new high points not shown on Drawings.
         2) Horizontal alignment plus or minus 1.0 foot.
      c. Include electronic monitoring of horizontal and vertical drilling head location. Obtain accuracy range within 1 inch of actual position of pipeline. Record position readings at maximum of 10 foot intervals.
      d. At completion of pilot hole drilling, furnish Engineer tabulations of horizontal and vertical alignment.
   3. When water is encountered.
      a. Provide and maintain dewatering system of sufficient capacity to remove water.
      b. Keep excavation free of water until backfill operation is in progress.
      c. Perform dewatering in such a manner that removal of soils particles are held to a minimum.
      d. Dewater into sediment trap.
   4. Maintain close observation to detect settlement or displacement of surface and adjacent facilities.
      a. Notify Engineer and applicable agency immediately if settlement or displacement is detected.
      b. Maintain safe conditions and prevent damage.

B. Drilling Operation.

1. Drilling Fluids.
    a. Maintain drilling fluid in bore hole to increase stability of surrounding soil and reduce drag on pulled pipe.
    b. Dispose of drilling fluid and other spoils at location following laws, ordinances, rules, and regulations of local jurisdiction.
    c. Transport excess fluids and other spoils to disposal site.
    d. Minimize drilling fluid at locations other than entry and exit points. Immediately clean up any drilling fluids that inadvertently surface.
    e. Provide clean water for drilling.
2. Pilot Hole Drilling.
    a. Angle entry hole so that curvature of pilot hole does not exceed allowable bending radius of HDPE pipe.
    b. Be able to make a turn of up to 90 degrees and maintain a curvature not to exceed allowable bending radius of HDPE pipe.
    c. Alignment Adjustment and Restarts.
        1) Follow pipeline alignment on Drawings within tolerances specified herein. Before adjustments, notify Engineer for approval.
        2) Notify Engineer when forward motion of operation is stopped by an obstruction.
            a) Abandon in place with drilling fluid, unless Engineer directs otherwise.
            b) Attempt a second installation at approved location or excavate at the point of difficulty and install the HDPE pipe by trench method following Section 02535.
        3) Exercise caution including, but not limited to, locating utilities, drilling downholes (test pits) to observe drill stems or reamer assembly to clear other existing utilities at locations following Drawings.
        4) Keep the number of boring pits to a minimum.

3.3 INSTALLATION

A. Installing HDPE Pipe.
1. Provide a swivel to reaming assembly and pull section of pipe to minimize torsional stress on pull section after drilling pilot hole.
2. Hold reaming diameter to 1.5 times outside diameter of HDPE pipe being installed.
3. Protect pull section as it proceeds during pull back so it moves freely and is not damaged.
4. Pull detection wire along with HDPE pipe. Extend wire into locator station at each end of HDPE pipe.
5. When connecting to adjacent pulled or non-pulled section of HDPE pipe, allow pull section of pipe to extend past termination point. Make tie-ins the next day after pullback of HDPE pipe.
6. Test pit pipe installation to verify horizontal and vertical alignment.
    a. One test pit for every 500 feet along length of pipeline.
    b. Engineer may order additional test pit for each test pit that reveals pipeline installation is not in compliance with Contract Documents.
7. Replace portions of pipeline not in compliance with Contract Documents.

B. Installing Locator Station.

1. Locator Stations.
   a. At each end of the HDPE pipe. Follow Standard Details or Drawings,
   b. Flush mount underground locator: See Standard Details.
   c. When HDPE pipe is connected to another type of pipe material, continue detector wire over connecting pipe, so locator station is installed out of paved area.
   d. In areas scheduled to be improved identify and protect station locations immediately after installation.
      1) Space 3 stakes equally around the station.
      2) Extend at least 4 feet above existing grade.
      3) Flag with orange fluorescent wrap within 6 inches from top of stakes.
   e. Manhole mounted locator station: See details on Drawings.
2. Detection Wire.
   a. Install detection wire without splices as shown on Standard Details.
   b. Terminate detection wire inside locator box using proper sized crimp type connectors on wire ends.
   c. Connect each wire to terminal maintaining at least 18 inches slack in each wire for underground flush mounted locator stations.
   d. Neatly coil slack wire in test station below terminal board.
   e. Locate wires on top and along HDPE pipe.
   f. Allow adequate slack and support to protect wires from damage during backfilling operations.
   g. Test each detection wire for continuity after backfill is completed.
      1) If test for continuity is negative, repair or replace.
      2) After continuity is verified, connect each detection wire to terminal block in locator station.

3.4 FIELD QUALITY ASSURANCE

A. Perform field testing of HDPE pipe following Section 02535 and Section 02512 if it is drinking water pipe.

END OF SECTION

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SECTION 02605

PRECAST MANHOLES AND VAULTS

PART 1 GENERAL

1.1 The Contractor shall furnish and install all manholes, covers, and accessories, and perform all repairs to existing manholes, as shown on the Drawings and specified herein, and tested by Contractor for approval by the Engineer.

1.2 SECTION INCLUDES

A. Aggregate and Backfill Materials.

B. Manhole and Vault Materials.

C. Manhole and Vault Accessories.

D. New Sanitary Sewer Manholes and Appurtenances.

E. Manhole Wall Reconstruction.

F. Pipe Connections to Manholes.

G. Manhole Testing.

1.3 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching

B. Section 02530 - Piping System Products

C. Division 3 - Concrete

1.4 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. Midwest Concrete Industry Board (MCIB) Standard Specification for Concrete Work.

B. American Society for Testing Materials (ASTM):
1. A-48 - Gray Iron Castings
2. A-615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. C-32 - Sewer and Manhole Brick (Made From Clay or Shale)
4. C-139 - Concrete Masonry Units for Construction of Catch Basins and Manholes
5. C-270 - Mortar for Unit Masonry
6. C-478 - Precast Reinforced Concrete Manhole Sections, except for the modifications herein.
7. C-923 - Specification for Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes
8. C-1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure Test

1.5 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Division 1.

A. Product Data for Review:
   1. Manholes, castings, manhole appurtenances.
   2. Manhole repair products
   3. Repair mortar

B. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.

C. Manufacturer's Certificate: Certify that products meet or exeed specified requirements.

1.6 FIELD MEASUREMENTS

A. Verify that field measurements and elevations are as indicated on the Drawings.

PART 2 PRODUCTS

2.1 AGGREGATE AND BACKFILL MATERIALS

A. Crushed rock: Crushed rock material used as a foundation and for leveling of manholes, shall be as specified in Section 02320 - Earthwork and Trenching. Granular pipe embedment material may also be used.

B. Backfill materials shall be as specified in Section 02320 - Earthwork and Trenching.

2.2 MANHOLE AND VAULT MATERIALS: Manhole materials shall conform to the details on the Drawings, and to the following:

A. Precast manholes and vaults: New manholes and vaults shall be constructed of precast concrete with developed base (DB) or precast concrete with cast-in-place (CIP) base.
   1. Precast concrete manholes with CIP base: The precast concrete manholes shall conform to ASTM C-478. All precast concrete shall be 4,000 psi with ASTM C-150, Type II cement. Concrete poured on site shall be 4,000 psi, as specified in Section 03300 - Cast-in-Place Concrete. Joints between the riser sections shall be a double gasketed joint of joint sealant material. Where possible, pipe openings for pipe connections shall be furnished with cast-in-place flexible entrance seals. Otherwise, pipe connections for pipes grouted in place shall be made using pipe grouting rings. Boxouts for grouting shall have surfaces grooved or roughened to improve grout bond.
   2. Precast concrete manholes with developed base: The precast concrete manhole shall conform to ASTM C-478. All concrete shall be 4,000 psi with ASTM C-150, Type II cement. The developed base shall be cast monolithic with the bottom riser section. The base reinforcement shall be continuous with the reinforcement of the bottom riser section. Manhole supplier shall verify that barrel reinforcement is sufficient for the depth of installation. Joints between the riser sections shall be a double gasketed joint of joint sealant material. Pipe openings shall be furnished with cast-in-place flexible entrance seals.
   3. The minimum shell thickness for precast reinforced manholes shall be:
      a. At a depth of 0 to 16 feet: One-twelfth internal shell diameter or 4 inches, whichever is greater.
      b. At a depth of 16 feet or greater: One-twelfth internal shell diameter plus one inch, or 5 inches, whichever is greater.

B. Adjusting rings: Adjusting rings shall be precast concrete, with circumferential reinforcement per ASTM C-478. The use of two or three grade adjustment rings under the manhole frame and cover is recommended in undeveloped areas where grade adjustment may be necessary.

C. Lifting notches: Precast sections may be provided with lifting notches on the inside faces of walls to facilitate handling. Lifting notches shall be not more than 3 inches deep. Holes extending through a wall will not be acceptable.

D. Castings: Manhole rings and lids shall be constructed of gray cast iron conforming to ASTM A-48. Castings for standard manholes shall be Neenah R-1726-A or approved equal with "Sanitary" cast on the lid. Castings for standard shallow manholes shall be Neenah R-1726-A or approved equal. Castings for "bolt-down lid" manholes and lids, as indicated on the Drawings, shall be Neenah R-1916-F or approved equal.

E. Protective coating: The protective coating for the exterior of manholes shall be Koppers Company, Inc. Bitumastic No. 50 or Tnemec Company, Inc. "Series 46-465 H.B. Tnemecol" or approved equal. Pre-cast manholes shall be shop coated.

F. Joint sealant: Joint sealant material used for sealing the joint between the manhole frame and chimney or corbel/cone section shall be preformed butyl rubber mastic joint sealant, BIDCO C-56 or equal.

G. Clay brick (for repairs to existing manholes): Clay or shale brick shall conform to the requirements for ASTM C-32, Grade MS or SM. Brick may be either solid or cored.

H. Mortar/Grout: Mortar/grout for brick work and other uses as required shall be a general construction grade grout prepared to a stiff, trowelable consistency. Grout product shall be a non-shrink, non-catalyzed grout containing mineral aggregate, and having a minimum compressive strength of 8,500 psi at 28 days in a plastic consistency. Grout shall be Master Builders "Construction Grout", W.R. Meadows "Sealtight CG-86", or equal.
   1. Preparation of grout mortar: Grout shall be prepared according to the recommended proportions of the manufacturer. Grout mortar may be extended with clean aggregate as recommended by the manufacturer. Grout mortar shall be mixed only in such quantities as needed for immediate use. The retempering of grout mortar will not be permitted.

I. Repair Mortar: Repair mortar shall be a one-component, shrinkage-compensated, cement based product. Repair mortar shall have a low permeability and be freeze/thaw durable and resistant to chlorides and sulfates. Repair mortar shall be a single-component product requiring only the addition of potable water for mixing. Repair mortar shall have a minimum compressive strength of 3,800 psi at 1 day and 11,000 psi at 28 days.
   1. For hand application: Master Builders "Emaco S88-CI" or approved equal.
   2. Pourable or pumpable: Master Builders "Emaco S77-CR" or approved equal.

2.3 MANHOLE AND VAULT ACCESSORIES

A. Pipe grouting rings: Pipe grouting rings shall be synthetic rubber, with stainless steel take-up clamps. Ring and clamps shall meet or exceed the requirements of ASTM C-923. Grouting rings shall be matched to the outside diameter of the carrier pipe. Grouting rings shall be Press-Seal Gasket Corporation "WS Series WaterSTOP Grouting Rings" or approved equal.

B. Flexible entrance seals: Cast-in-place flexible entrance seals shall be "A-LOK" flexible seals manufactured by A-LOK Products Incorporated or "Press Wedge II" manufactured by Press-Seal Gasket Corporation or approved equal.

PART 3 EXECUTION

3.1 SEPARATION OF WATER AND SEWER UTILITIES

A. SEWER MANHOLES: No water pipe shall pass through or come in contact with any part of a sewer manhole.

3.2 NEW MANHOLES: New manholes shall be constructed of precast concrete sections, with cast iron frames and covers in accordance with the Drawings and as specified herein.

A. Handling: Precast concrete sections shall be handled carefully and shall be protected during transport, storage and installation from shock and free fall. Hooks shall not be permitted to come into contact with joint surfaces. Per ASTM C-478, damaged sections adversely affecting the watertightness of the sections shall be replaced with new sections, except when repairs are permitted by the Engineer.

B. Inspection: Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

C. Manhole construction:

1. Precast concrete manholes with cast-in-place base: Construct manhole with precast concrete section on a cast-in-place concrete foundation slab as shown on the Drawings. Concrete base shall be poured over a base of crushed stone. Joint seals between each riser section shall be installed in strict conformance with manufacturer's recommendations. Damaged exterior coating shall be touched up and allowed to dry prior to backfilling.
2. Precast concrete manholes with a developed base: Precast manholes with a developed base shall be placed on a base of crushed stone as detailed on the Drawings. The crushed stone base shall be graded smooth, level and to the correct grade. The bottom riser section shall be placed upon the crushed stone base and checked for alignment, elevation and plumbness. If not correct, the bottom riser section shall be completely removed from the excavation and the crushed stone base reshaped. Pipe connections to the manholes shall be in strict conformance with manufacturer's instructions for installation of the flexible entrance seals. Joint seals between each riser section shall be installed in strict conformance to manufacturer's recommendations. Damage to exterior coating shall be touched up in the field prior to backfilling.

D. Inverts: The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section.

1. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly.
2. The floor of the manhole outside the channels (the bench) shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot.
3. Invert channels shall be formed in the field using either concrete readi-mix, or clay brick and mortar as specified herein. Where brick and mortar used, mortar shall be placed completely around each brick to a minimum thickness of 3/8 inch. Manhole inverts formed directly in the concrete of the manhole base of developed-base manholes will not be acceptable.

E. Flexible entrance seals: Where cast-in-place flexible entrance seals are used to seal pipe connections to new manholes, the concrete or mortar of the field-installed invert shall extend exactly half-way up the pipe, to the springline. No concrete or mortar shall be placed around the pipe on the exterior of the manhole.

F. Frames and covers: Unless shown otherwise on the Drawings, all castings shall be set flush with finish grade in all roadways and lawns, and at least 12 inches above finish grade in all other areas.

3.3 MANHOLE WALL RECONSTRUCTION

A. Where damaged by the Contractor's operations, required by other sections, or indicated on the Drawings, the walls of existing manholes shall be rebuilt using clay brick and mortar. If repair of the manhole wall is adjacent to the sewer pipe wall penetration, repair mortar shall be used in place of mortar.

B. Where joining new work or repair work to existing surfaces, the existing surfaces shall be solid, clean, and sufficiently rough to create a good bond. If surfaces of existing materials are not solid or are prone to crumbling, Contractor shall remove existing materials as required to reach a clean, hard surface.

C. Brick units shall be laid in such a manner that the courses are true to line and the joints fully bonded.
   1. In a structure of circular cross section, the bricks shall be laid with the long dimension radially in the structure.
   2. In a structure of rectangular design, the bricks shall be laid in alternate courses of headers and stretchers.

D. Exterior faces of masonry shall be plastered at least ½-inch thick with mortar.

3.4 PIPE CONNECTIONS TO MANHOLES

A. Pipe connection to new manholes shall be as shown on the Drawings.

B. Pipe connection to new manholes shall be made with cast-in-place flexible entrance seals wherever possible, following the entrance seal manufacturer's instructions.

C. Pipe connection to existing manholes, and to new manholes where boxouts are used shall be made with approximately two inches clearance surrounding the pipe or fitting. A pipe grouting ring shall be placed around the outside of the pipe where the pipe enters the manhole. The opening between the pipe and structure shall be filled with repair mortar to form a water tight seal.

D. Pipe connections to existing manholes shall be made in such manner that the finish work will conform to the essential applicable requirements specified for new manholes, including all necessary concrete work, cutting and shaping. When new sewer piping is connected to an existing manhole, manhole benches and invert shall be repaired using repair mortar.

E. Repair Mortar: Repair mortar used to fill voids around pipes or to repair walls and benches of manholes shall be mixed, applied, and cured according to the manufacturer's recommendations.
   1. Preparation: Surfaces to receive repair mortar shall be solid and free of oil and grease. The concrete surfaces to receive repair mortar shall be saturated or in a saturated, surface-dry condition as recommended by the manufacturer. The mix may be extended with pea gravel or other suitable aggregate, as limited by the manufacturer's recommendations.
   2. Mixing shall be accomplished with a slow speed drill equipped with a paddle or an appropriate size mortar mixer.
   3. Placement: Repair mortar used to fill voids and holes shall be hand-placed in plastic form or poured in flyable form, as required by the manufacturer's recommendations for the product used.
   4. Application of repair mortar in vertical and horizontal layers shall conform to the thickness limitations of the manufacturer.
   5. Curing: Repair mortar shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. The repair mortar shall be wet cured for at least 7 days. As

an alternative to moisture curing, a two-coat application of a curing compound recommended by the manufacturer may be used.

3.5 MANHOLE TESTING

A. Manhole leakage test: All new precast manholes and existing manholes which have been rehabilitated shall pass a vacuum leakage test. Contractor shall conduct vacuum tests.

B. Notification: Contractor shall notify Engineer at least 48 hours in advance the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.

C. Pre-Test Inspection: All precast concrete manholes shall be visually inspected to determine the presence of misaligned, displaced, broken manhole sections or other physical defects. All defects shall be satisfactorily corrected prior to conducting vacuum leakage tests.

D. Each manhole shall be tested immediately after assembly and prior to backfilling. All lifting holes shall be plugged with repair mortar. No standing water shall be allowed in the excavation during testing.

E. Vacuum testing procedure: All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to nine inches. The manhole shall pass if the time is greater than 60 seconds for a 48-inch diameter manhole, 75 seconds for 60 inches, and 90 seconds for 72 inches. If the manhole fails the initial test, necessary repairs shall be made by replacing the joint seals and/or pipe seals. Retesting shall proceed until a satisfactory test is obtained. If the joint mastic or gasket is displaced during the vacuum testing, the manhole shall be disassembled, the seal replaced and the manhole retested. Manholes which cannot be made to pass in this manner shall be replaced.

3.6 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400 - Quality Control.

END OF SECTION

SECTION 03300

MISCELLANEOUS CONCRETE

PART 1 GENERAL

1.1 GENERAL

A. The Contractor shall provide all concrete work as required to complete the concrete construction as specified herein and as shown on the Drawings.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. American Concrete Institute (ACI):
1. 302 - Guide for Concrete Floor and Slab Construction.
2. 304 - Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
3. 305 - Committee Report on Hot-Weather Concreting.
4. 306 - Committee Report on Cold-Weather Concreting.
5. 309 - Recommended Practice for Consolidation of Concrete.
6. 318 - Building Code Requirements for Reinforced Concrete.
7. 347 - Recommended Practice for Concrete Formwork.

B. American Society for Testing and Materials (ASTM):
1. A-615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement
2. C-31 Making and Curing Concrete Test Specimens in the Field.
3. C-33 Concrete Aggregates.
4. C-39 Compressive Strength of Cylindrical Concrete Specimens.
5. C-94 Ready-Mixed Concrete.
6. C-143 Slump of Portland Cement Concrete.
7. C-150 Portland Cement.
8. C-185 Test Method for Air Content of Hydraulic Cement Mortar

C. Midwest Concrete Industry Board (MCIB).

1.4 SUBMITTALS

A. Contractor shall submit product data for review on the following items required by this Division:
1. Laboratory name.
2. Aggregate testing and gradation.
3. Design mix.

B. Product data shall be submitted in accordance with Section 1300 - Submittals.

PART 2 PRODUCTS

2.1 CEMENT: Cement shall conform to ASTM C-150, Type I. Cement may be bagged or bulk. Cement shall be used from only one mill throughout the entire project.

2.2 FINE AGGREGATE: Fine aggregate shall conform to ASTM C-33 and have the following gradation:

Sieve	% Passing	% Retained
3/8"	100	0
No. 4	95-100	0-5
No. 8	80-100	0-20
No. 16	50-85	15-50
No. 30	25-60	40-75
No. 50	5-30	70-95
No. 100	0-10	90-100

2.3 COARSE AGGREGATE

A. Coarse aggregate shall conform to ASTM C-33 and have the following gradation:

Sq. Sieve	% Passing	% Retained
1"	100	0
3/4"	90-100	0-10
3/8"	20-55	45-80
No. 4	0-10	90-100
No. 8	0-5	95-100

2.4 WATER

A. Treated and filtered water from a municipal or other public water supply district shall be used.

2.5 REINFORCING STEEL

A. All bars shall conform to ASTM A-615, Grade 60. Bending details shall conform to ACI 318.

2.6 FORMS

A. The forms shall be true and rigid and conform to shape, line and dimensions as shown on the Drawings. All forms shall be rigidly constructed, braced and tied to prevent any deflection or displacement during placing of concrete. All exposed corners and edges shall have 3/4-inch fillets or chamfers. All joints shall be mortar tight; open joints shall be sealed as required.

2.7 CONCRETE MIX

A. Proportioning: Concrete shall conform to the following:
   1. Cement: 6 sacks per cubic yard, minimum.
   2. Water: Water shall be kept to an absolute minimum to maintain slump as specified.
   3. Aggregate: The sand factor shall be as required to give the best workable mix within the range of 46 to 52 percent of total aggregate by weight.
   4. Strength: Minimum 4000 psi at 28 days.

B. Slump: The maximum slump shall not exceed 4 inches. Determination of slump shall conform to ASTM C-143.

C. Mixing: Contractor shall use ready-mixed concrete, mixed and delivered in conformance with ASTM C-94.

D. Admixtures: Air entraining agents shall be added to the concrete to provide 4 to 6 percent entrained air when placed, in conformance with ASTM C-185.

PART 3 EXECUTION

3.1 PLACING REINFORCING STEEL

A. All bars are to be accurately placed and securely tied at all intersections.

B. Reinforcing steel shall be free from flaky or scaly rust which will destroy or reduce the bond strength at the time concrete is placed.

C. Unless shown otherwise on the Drawings, the following minimum concrete coverage shall be maintained:
1. Against earth: 3 inches
2. Against forms or when exposed to water or weather: 2 inches

3.2 PLACING CONCRETE

A. No concrete shall be deposited below water. The excavation may be damp but shall contain no free water.

B. Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent the separation or loss of materials. Re-tempering of concrete is not permissible.

C. All concrete shall be thoroughly compacted during placement by means of vibrators in conformance with ACI 309.

D. For formed surfaces, the Contractor shall break off ties, grout voids which are deeper than 1/2-inch and chip out honeycombed areas to solid concrete and grout flush with formed surface.

E. Curing shall be maintained continuously for seven days after placing concrete or until forms are removed and the surface finished. Concrete surface temperature is to be maintained between 50°F and 100°F for at least seven days.

F. Concrete shall not be placed on iced or frozen subgrade or when the air temperature is below 20°F. Concreting shall not be continued when the air temperature is below 45°F unless the following conditions are attained:
1. Mixing water shall be heated (to a maximum of 150°F).
2. Aggregates shall be heated until free of all ice and frost.
3. The concrete temperature after mixing shall be between 50°F and 70°F if the air temperature is 20°F to 45°F.
4. After the concrete is placed, it shall be covered, protected, and heated so as to maintain a minimum of 70°F air temperature for the first 24 hours and 50°F air temperature for the next six days. Open-flame type heaters are not permitted. Heating equipment not vented outside of the covering will not be permitted.
5. Moist conditions shall be maintained during the heating period.
6. All covering, heating equipment, etc., shall be on hand and approved by the Engineer before any concrete is placed.

G. Admixtures, such as calcium chloride, shall not be used.

H. Exposed concrete is not to be placed in air temperatures above 100°F. Cover, protect and cool work as required to maintain the temperature of the concrete below 100°F. The concrete temperature, after mixing, shall not be greater than 85°F. Spray and/or shade aggregate piles and cool mixing water as required.

3.3 FINISHING

A. Unformed Surfaces:

1. Screed Finish:
   a. Use as first stage for all concrete finishes.
   b. Use as final finish on surfaces that will be covered by additional concrete, grout placement, or mortar setting bed except as otherwise specified.
   c. Immediately after screeding, use a wood float, darby, or bull float to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces so that surface irregularities do not exceed 3/8 inch in 10 feet when used as final finish.
2. Floated Finish:
   a. Use as second stage of broomed, troweled, or magnesium-troweled finish.
   b. Use as final finish on all areas to receive built-up roofing.
   c. Float with mechanical float. Hand floating will be permitted only in areas inaccessible to mechanical float.
   d. On surfaces not to receive troweled or magnesium-troweled finish, finish with wood or cork float after mechanical floating to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.
3. Broomed Finish:
   a. Use as final finish on all outdoor slabs including pavements and sidewalks.
   b. After floated finish, draw a stiff bristle broom across the surface making uniform corrugations, perpendicular to the direction of traffic, not more than 1/16 inch deep.
4. Troweled Finish:
   a. Use as final finish on inside floors and on all other unformed surfaces not otherwise indicated or specified.
   b. Trowel with steel trowel, mechanical or hand, to obtain a smooth, dense finish. The final troweling shall be done after the concrete has become hard enough so that no mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.
   c. Do not trowel before surface water has evaporated or has been removed with a squeegee.
   d. Finish to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.
   e. Do not add sand or cement to the floor surface.
5. Magnesium-Troweled Finish:
   a. Perform as specified for Troweled Finish, this Section, except use a magnesium trowel by hand instead of a steel trowel to obtain a dense, but not slick, finish.
   b. Use where floor will receive protective coating after curing.
6. Stair-Tread Finish:
   a. Apply to all interior and exterior concrete stair treads and landings that do not have abrasive nosings.
   b. Spread fine abrasive aggregate uniformly on concrete before it has set, in the amount of not less than 1/4-pound aggregate per square foot, and steel trowel into surface of concrete.
   c. Expose abrasive aggregate slightly by rubbing with an abrasive brush after concrete finish has set and cured.
   d. Aggregate and application shall conform to Specification “A” of the Norton Company.

7. Contraction Joints:
   a. Locate as indicated.
   b. Maintain true alignment with straightedge.
   c. Joints shall be grooved except where sawed joints or preformed joints are indicated.
   d. Grooved Joints:
      1) Perform during the finishing process.
      2) Width of groove shall not exceed 1/4 inch.
      3) Depth of groove shall be at least 1 inch.
   e. Sawed Joints:
      1) Cut joints with power blade as soon as concrete surface is firm enough to resist tearing or damage by the blade and before random shrinkage cracks can occur. (Usually required within 4 to 12 hours after finishing.)
      2) Make joints approximately 1/8 inch wide with depth as indicated.
      3) Seal with the same type sealant specified for expansion joint sealant.
   f. Preformed Joints:
      1) Install preformed joints as recommended by manufacturer.

B. Formed Surfaces:
   1. Repair surface defects as specified under Repair of Defective Surfaces, this Section.

C. Repair of Defective Surfaces:
   1. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area.
   2. Repairing:
      a. Repair as soon as forms have been removed.
      b. Chip surface back to minimum depth of ½ inch, chip edges perpendicular to surface, pre-wet depression and brush with heat cement immediately before patching.
      c. Patch surfaces using still mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.
      d. Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and rod for compacting the holes.
      e. Moist-cure for 3 days or use curing compound.
      f. Engineer shall be notified of areas containing defects or where reinforcing steel is exposed, prior to determination of repair method.

3.4 FLOOR SURFACE TREATMENT

A. Apply sealer in accordance with manufacturer's instructions on scheduled floor surfaces.

B. Prior to placing floor sealer, all stains from oils, greases, etc. shall be removed.

3.5 CONCRETE TEST CYLINDERS

A. Test cylinders are not required for the concrete anti-flotation ballast.

B. All concrete test cylinders shall be provided by the Contractor, using a licensed testing laboratory. The making and testing of test cylinders, including transportation and all expenses, shall be paid for by the Contractor.

C. The Contractor's testing laboratory shall make at least four (4) test cylinders for each day's pour in excess of 6 cubic yards of each class of concrete, and two test cylinders for each additional 50 cubic yards or major fraction thereof, as directed by the Engineer.

D. The Contractor shall ship the test cylinders to the laboratory on the fourth day, where the laboratory shall proceed to cure until tested. One cylinder shall be tested on the seventh day, and two cylinders tested on the 28th day (leaving one spare cylinder). The test cylinders shall be identified at the time cast, and as to which pour is represented. Unsatisfactory tests of cylinders shall make the concrete represented subject to rejection, with consequent removal and replacement required.

E. Concrete test cylinders shall be cast and tested in accordance with ASTM C-31 and C-39. The testing laboratory shall furnish four (4) copies of test reports for test cylinders for slump, air, temperature and compressive strength and distributed as follows:
1. 2 copies - Engineer
2. 2 copies - Contractor

END OF SECTION

SECTION 11307

SUBMERSIBLE GRINDER PUMP STATION

PART 1 GENERAL

1.1 SUMMARY

A. General: This Section includes equipment, material, and service requirements for furnishing and installing grinder pumps and accessories. The principal items shall include, but not be limited to, the following: submersible centrifugal grinder pumps; guide rails; wetwell access hatch; discharge seals, pump discharge and anchoring elbows, valves, bolts including anchor bolts, nuts and gaskets, controls, and any other appurtenances.

B. Single Source: The pumping equipment and controls shall be the product of a single supplier.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 01750 - Starting of Systems

C. Section 02320 - Earthwork and Trenching

D. Division 16 - Electrical

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. American Society for Testing and Materials (ASTM):
1. A36 - Standard Specification for Carbon Structural Steel
2. A48 - Standard Specification for Gray Iron Castings
3. D883 - Definitions of Terms Relating to Plastics
4. D3753 - Glass Fiber Reinforced Polyester Manholes and Wetwells

B. American Iron and Steel Institute (AISI).

C. National Electrical Manufactures Association (NEMA).

D. National Fire Protection Association (NFPA):
1. 70 - National Electrical Code (NEC).

E. National Safety Council.

1.4 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Section 01300 - Submittals:

A. Submit shop drawings and product data under provisions of Section 01300-Submittals.

B. Warranty for pumps and controls, on manufacturer's letterhead.

C. Submit locations of the nearest permanent service headquarters of the pump and motor manufacturers.

D. Submit descriptive literature, including a cross-sectional view of each pump and motor combination, which indicates materials of construction, weights, principal dimensions and other important details.

E. Record Drawings: Submit record drawing under provisions of Section 01700-Contract Closeout.

F. The Pump manufacturer shall provide approved Operation and Maintenance Instructions, which includes the following:
   1. Each set of O&M Instructions shall include separate performance criteria and unique characteristics of pump. Information which applies to all pumps may be provided only once per set, if clearly identified as applying to all units.
   2. Manuals shall include the required service training information listed above and shall include detailed drawings with detailed parts listing, wiring diagrams and schematics for all pump components. Operation and maintenance manuals shall be submitted for Engineers approval.

1.5 QUALITY ASSURANCE

A. All materials used shall be new, of high grade and of properties best suited to the Work required.

B. Manufacturer's Qualifications:
   1. Pumping equipment provided under this Section shall be standard product in regular production by manufacturers whose products have proven reliable in similar service for at least five (5) years.
   2. Manufacturer shall satisfy the Engineer that they are capable of the following:
      a. Providing local factory trained personnel to service the pumps and allied equipment when needed within 24-hour period.
      b. Providing needed spare parts for the pumps within 48-hour period.

C. Coordination Responsibility: Contractor shall retain overall responsibility for equipment coordination, installation, testing and operation.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver equipment to site under provisions of Section 01600 - Material and Equipment.

B. Store and protect equipment under provisions of Section 01600 - Material and Equipment.

C. Store all equipment off the ground in enclosed shelter.

1.7 FACTORY ASSEMBLY

A. Pump/motor units shall be completely shop assembled and aligned prior to shipping.

B. After completion of the specified factory tests, pumps shall be prepared for shipment with the minimum amount of disassembly, and such that no field disassembly, cleaning, or flushing is required.

C. Any components removed for shipping shall be match-marked prior to removal and shipment.

D. Prepare surfaces and provide paint system standard of the manufacturer and suitable for service intended.

1.8 WARRANTY

A. Pumping Equipment: The pump manufacturer shall provide a warranty with coverage as given below. Warranty shall not commence before startup of all pumping units by manufacturer's authorized representative, in accordance with Division 1 of the Specifications.
   1. The controls shall be covered for one (1) year against defects. Warranty shall cover 100 percent of the cost of both parts and labor for repair or replacement, with no prorating over this term.
   2. Pumping units shall be covered for one (1) year against defects in materials and workmanship. Wear items including mechanical seals and bearings shall be covered under the warranty. Wearing rings may be excluded from the warranty. Obligation of manufacturer under warranty shall be to cover the cost of both parts and labor for replacement. Coverage shall be full and not pro-rated. Owner shall cover the cost of pump delivery to manufacturer's local service center in the Kansas City area. Manufacturer shall cover return shipping. Owner will re-install equipment.

B. Service Calls:
   1. Pump manufacturer or his authorized representative may visit the installation as he sees fit to troubleshoot and inspect the pumps during the warranty period. Manufacturer's service personnel shall contact the Owner at least one working day prior to such visits.
   2. When Owner has notified the manufacturer of a problem, manufacturer shall respond promptly. If a pump is out of service or if the controls system is experiencing problems, manufacturer shall arrive to service the installation not more than 48 hours after notification by Owner. A factory trained and authorized technician shall be available to address problems with the pumps and controls.
   3. Manufacturer may elect to try and direct Owner's personnel to correct the problem, if the problem is simple and Owner is able to assist. If unsuccessful, such efforts shall not eliminate manufacturer's responsibility to make a service call.
   4. Manufacturer shall maintain a log of all service performed on the equipment during the warranty period, and shall furnish Owner a copy of this log upon request, and at the end of the warranty period.
   5. Manufacturer shall provide Owner with necessary forms to accurately keep records of maintenance.

C. Effective Date: The warranty shall become effective upon Substantial Completion of the Work, or the date which the last of the pumps is started, whichever is first. Warranty shall <u>not</u> commence on the date of delivery nor of shipment.

1.9 MANUFACTURER'S FIELD SERVICES: An authorized representative of the manufacturer shall provide the following:

A. Start-up Services: As required, with a minimum of two 6-hour sessions, of which at least 3 hours shall be dedicated to demonstration and training. Demonstration and training shall cover at least the following:
   1. Controls function and sequence of operation.
   2. Maintenance procedures, including use of megohm meter and how to interpret results.
   3. Proper removal and installation of submersible pumps.

B. Provide services for end-of-warranty-period inspection.

C. Provide additional services to repair or correct any deficiencies noted at start-up or warranty inspection.

D. On-site Testing: As specified herein.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers
1. Flygt (Xylem)
2. Keen
3. Myers
4. Engineer Approved Equal

B. Equivalent Products: Subject to the requirements of Section 01600.

2.2 GENERAL

A. Pumps shall be designed for continuous operation without cavitation within the specified pump range as shown on the Drawings. Pumps shall be designed to operate up to one hour in air without damage. The pump shall have as high efficiency as possible at the rated capacity. The NPSHR at the maximum operating capacity shall not exceed 26 feet. All seals shall be solvent resistant.

B. Grinder pumps shall contain special cutters to reduce sewage to a fine slurry, using stationary and rotary cutters.

2.3 MATERIALS AND CONSTRUCTION

A. Grinder Pump Station
1. Performance Schedule:

Pump Station Name	Maintenance Facility Lift Station
Number of Units	2
Rated Total Head, feet	45
Minimum Capacity (per pump) at Rated Total Head, g.p.m.	20
Minimum Shut-Off Head, feet	60
Operating Head Range, feet	40-50
Max (nominal) Pump Operating Speed at Rated Head, rpm	3450
Motor Power (Volts/Ph/Hz)	230/1/60
Maximum Nameplate HP	3
Discharge Size, inches	1.25

2. Wiring: Pump power and level control wiring shall be field installed by a certified electrician. All electrical cables penetrating or passing through the conduit flange of the pump station must be water-tight and sealed by the electrician immediately upon installation. Color coded insulated wire for power cord, and insulated wire for float level sensors if required.
3. Check Valves:
    a. Pump discharge pipe shall be equipped with a factory-installed gravity-operated check valve. The valve will provide a fully ported passageway when open and shall introduce a friction loss of less than six inches of water at maximum rated flow. Working parts shall be made of heavy duty cast iron or 300 series stainless steel.
4. Level Detection:
    a. Level detection for controlling pump and alarm operation shall be controlled by one of the following.
        1) By use of mechanical float switches. Switches utilized in the system shall be hermetically sealed in a submersible watertight protective housing securely attached to a PVC float tree with wire tie. Float switch cord will be securely tightened 4 inches maximum above float.
        2) By use of level sensing controls which monitor the pressure changes in an integral air column connected to a pressure switch. The air column shall be integrally molded from a thermoplastic elastomer suitable for use in wastewater.
    b. Level detection device shall be designed to be protected from solids, greases, oils, fats and corrosive sewer gases. Switch shall have high impact, corrosion resistant housing for use in sewage and water up to 140°F (60C).
5. Shut-Off Valve: The pump discharge pipe connection shall be equipped with a shut-off valve and a quick disconnect. The valve shall be fully ported, constructed of bronze with stainless steel ball, stainless steel stem and hardware, and Teflon seats, with a minimum rated pressure of 150 PSI. A 304 stainless steel extension valve handle will be supplied for manual operation from top of basin secured with stainless steel support bracket.
6. Anti-Siphon Valve: The pump discharge shall be equipped with a factory-installed integral anti-siphon valve built into the discharge piping after the check valve.
7. Fiberglass Tank: The tank shall be a wetwell design consisting of a single wall, laminated fiberglass construction. The resin used shall be of a commercial grade suitable for the environment. The reinforcing material shall be a commercial grade of glass fiber capable of bonding with the selected resin. The inner surface shall have a smooth finish and be free of cracks and crazing. The exterior tank surface shall be relatively smooth with no exposed fiber or sharp projections present. The tank wall and bottom shall be of sufficient thickness and construction to withstand the imposed loading due to saturated soil at the specified burial depth for each available tank height. All station components must function normally when exposed to the external soil and hydrostatic pressures developed at the specified burial depth. The tank bottom shall be reinforced with a fiberglass plate extending beyond the tank walls to support concrete anchoring, as required, to prevent flotation.

B. Pumps
1. Design
    a. Each grinder pump shall be a heavy duty pump used as a grinder. Each grinder pump shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of “foreign objects”, such as paper, wood, plastic, glass, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4” diameter discharge piping.
    b. The cutter materials shall provide maximum corrosion and abrasion resistance. The remaining portion of the grinder pumps, with the exception of seal materials and wet end, shall be similar to the heavy duty pumps used in larger pump stations for daily operation.

2. Casing:
    a. Major pump components shall be of gray cast iron, ASTM A-48, Class 30, Class 35B, or Class 40B, with smooth surfaces devoid of blow holes and other irregularities. Where watertight sealing is required, O-rings made of solvent resistant material shall be used. All exposed nuts and bolts shall be of ASTM A276 Type 304 stainless steel or brass
    b. All mating surfaces where watertight sealing is required shall be machined and fitted with solvent resistant O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of nitrile rubber O-rings without the requirement of a specific torque limit.
3. Cable Entry:
    a. The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top.
    b. Cable shall be capable of operating under continuous submergence without loss of watertight integrity to a depth of 50 feet.
4. Submersible Motor:
    a. The pump motor shall be a squirrel-cage, induction, shell type design, housed in a watertight chamber. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation which will resist a temperature of 155°C (311°F). The stator shall be dipped and baked three times in Class F insulation. The motor shall be designed for continuous duty handling pumped media at a liquid temperature of 104°F per NEMA/FM requirements without overheating or operating in service factor. Service factor shall be 1.15 in accordance with NEMA MG1. Motor shall be non-overloading over the entire range of performance curve. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency.
    b. Motors shall be equipped with thermal switches attached to or imbedded in the motor windings and connected in series. These thermal switches shall be used in conjunction with external thermal overload protection and shall be connected to the control panel. One switch shall be provided per stator phase. The tripping of at least one switch shall shut down the motor and activate an alarm. The temperature switches shall automatically reset once the stator temperature returns to normal.
    c. Pump motors and all associated wet well equipment shall be FM rated explosion proof for Class I, Division I, Groups C and D.
5. Shaft: The pump shaft shall be of AISI Type 420 or 431 stainless steel. This is a nickel bearing chromium steel designed for heat treatment to high mechanical properties providing superior corrosion resistance characteristics.
6. Pump Seal: Each pump shall be provided with a tandem mechanical shaft seal system.
    a. The upper of the tandem set of seals shall operate in an oil chamber located just below the stator housing. This set shall contain one stationary ring and one positively driven rotating ring and shall function as an independent secondary barrier between the pumped liquid and the stator housing. Seal faces shall be tungsten carbide/carbon or hardened tool steel/ carbon.
    b. The lower of the tandem set of seals functions as the primary barrier between the pumps liquid and the oil housing. This set shall consist of a stationary ring and a positively driven rotating ring. Seal faces shall be tungsten carbide/ tungsten carbide or silicon carbide/silicon carbide.

c. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring action between upper and lower seal faces shall not be considered acceptable.

7. Seal Failure Detection: A moisture detection system shall be provided to detect the presence of water as follows. Leakage sensors shall not be wired in series with motor thermal switches.
   a. Capacitance probe(s) shall be provided in the seal chamber. The sensor(s) will be connected to the external monitoring unit, and when moisture is detected, will activate a seal moisture alarm. The pump will be shut down.
8. Bearing: The pump shaft shall rotate on two (2) permanently lubricated bearings. The upper bearing shall be a single row roller bearing and the lower bearing a two row angular contact ball bearing.
9. Impeller:
   a. The impeller shall be of gray cast iron, Class 30, Class 35B, or Class 40B, dynamically balanced, single shrouded non-clogging design having a long throughways without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage application. The pump manufacturer shall, upon request, furnish mass moment of inertia data for the proposed impeller. The fit between the impeller and the shaft shall be a sliding fit with one key. Securing of the impeller shall be accomplished via a special taper action, locking device for pumps up to 7.5 kW and by a screw, locking washer and a key for larger pumps.
   b. The volute shall be of a single piece, non-concentric design and shall have smooth fluid passages large enough at all points to pass any size solids which can pass through the impeller.
   c. A wear ring system shall be installed to provide efficient sealing between the volute and impeller. The wear ring system shall consist of a stationary ring made of nitrile rubber molded with a steel ring insert which is drive fitted to the volute inlet, and a rotating stainless steel AISI 304 ring which is drive fitted to the impeller skirt. For pumps 10 HP and below, pumps shall be equipped with brass and nitrile rubber volute wear ring only.
      1) In lieu of a wear ring system, pumps design may utilize a self-cleaning front plate made of ASTM A48 Class 40 cast iron, mounted to the volute with four stainless steel adjusting screws to permit close tolerance adjustment between the front plate and impeller. The front plate shall be designed with an outward spiraling V-shaped groove on the side facing the impeller, to force stringy solids outward from the impeller.
   d. Cutters: Pump shall have rotating cutters mounted on the pump shaft directly against the impeller, and stationary cutters mounted on a bottom plate. Cutters shall be made of AISI 440C hardened stainless steel, with a hardness or 58 - 62 Rockwell C.
10. Bolts, Studs and Nuts:
   a. All bolts studs and nuts shall have American National form right-hand machine cut threads which shall be in conformity with the current ANSI B1.1, “Screw Threads”, Coarse Thread Series, Class 2 Fit, unless otherwise specified.
   b. Bolt heads and nuts shall be semi-finished and shall be in conformity with ANSI B18.2, “Wrench-Head Bolts and Nuts and Wrench Openings”, Heavy Series, unless otherwise specified. All nuts shall be hexagonal in shape.
   c. Steel anchor bolts, flange bolts, studs and nuts shall be Type 316 stainless steel.

C. Pump Lifting: Provide grab-link system, with short length of stainless steel chain, nylon cord, and link attachment device.

D. Guide Rails:
   1. Stainless-steel pipe.
   2. All 316 or 304L stainless steel, including rails, brackets, and anchor bolts.
   3. Shall not support any portion of the pump weight.
   4. Provide stainless steel guide rail supports bolted to wetwell walls, at maximum of 15 foot intervals along rails. Not required when length of guide rails is less than 15 feet.
   5. Provide upper guide rail bracket, cast iron or stainless steel.

E. Aluminum Access Hatches:
   1. Access hatches in exterior locations shall be floor door type, designed to withstand a live load of 300 pounds per square foot.
   2. Door leaves shall be 1/4 inch thick aluminum diamond pattern plate.
   3. Hatches shall open to 90 degrees. Devices shall be provided for easy operation, including an automatic hold open arm with release handle for each door leaf. A snap lock with removable handle shall be provided for each hatch.

F. Alarm/Control Panels
   1. Refer to DIVISION 16 for controls.

G. Pump Protection System: Furnished by pump manufacturer.
   1. Furnish a complete pump monitoring and protection system consisting of a intrinsically safe solid state monitoring module to be installed in the motor starter cubicle and independent probes integral to the pump/motor, as specified herein, wired to a sealed cable entry terminal box for connection of submersible control cables.
   2. Monitoring unit (or multiple such) shall be a solid-state module designed for mounting within the motor starter cubicle or as indicated on the Drawings. Monitoring unit shall employ conventional logic and noise isolated electronics. Monitoring unit shall accept inputs from the sensors (seal leakage, motor over temperature) specified and shall output independent contacts which close to alarm each condition, or separate independent output terminals suitable for direct connection to interposing relays for alarm contact development. Provide a separate N.C. alarm contact, rated at 120V, 5A inductive, which opens on any failure. The monitoring unit shall accept separate isolated N.O. contacts which close to indicate pump running and to reset after pump trip.

2.4 ELECTRICAL EQUIPMENT AND CONTROLS

A. Refer to DIVISION 16 for electrical control panel, motor starters, and pump controls.

PART 3 EXECUTION

3.1 INSTALLATION: The grinder pump station and related components shall be installed in accordance with the manufacturer’s recommendations.

A. All Work shall conform to the Drawings, the manufacturer’s recommendations, and the requirements of Section 16000.

B. The diameter of the excavated hole must be large enough to allow for the concrete anchor.

C. A concrete anti-flotation ballast, as shown in drawing details and sized according to the manufacturer's instructions, shall be precast to the pump station or poured in place. If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8-inch sleeve is required over the inlet prior to the concrete being poured.

3.2 START-UP AND TESTING

A. The manufacturer shall provide the services of a qualified factory trained technician who shall inspect the placement and wiring, perform field tests as specified herein, and instruct the Owner's personnel in the operation and maintenance of the equipment before the stations are accepted by the Owner.

B. All equipment and materials necessary to perform testing shall be the responsibility of the Contractor. This includes, as a minimum, a portable generator and power cable (if temporary power is required), water in the basin (filled to a depth sufficient to verify the high level alarm is operating), and opening of all valves in the system. These steps shall be completed prior to the qualified factory trained technician(s) arrival on site.

3.3 ON-SITE PERFORMANCE TESTS

A. Conducted by pump manufacturer's authorized representative in presence of Contractor and Engineer.

B. Equipment Tests:
1. Check performance of all components as a functioning unit.
2. Check alignment of each unit.
3. Confirm proper rotation of impeller.

C. Operational Tests:
1. Conduct such operational tests as necessary to determine that the performance of equipment and controls is as specified.
2. Tests will generally consist of placing equipment in operation under varying conditions and verifying performance (including no-load).
   a. Test all control sequences and functions.
   b. Perform complete meg-ohm testing.
   c. Take amperage and voltage readings.
3. Dry Run Test: No liquid is to be allowed to enter the inlet of the pump. The exterior of the pump shall be dry and remain dry during test. Test duration shall be a minimum of 30 minutes.

D. Capacity Test: On three occasions, wet well shall be filled with liquid to an elevation sufficient to allow each single pump to operate for three minutes, independent of the control regime. Time required to pump down known volume shall be measured as evidence of each pump's capacity. All portions of the force main must have been constructed and tested prior to this test.

E. Make all necessary equipment adjustments and corrective work indicated by tests. Repeat testing as necessary.

F. Submit a written test report to General Contractor (with one copy to Engineer) in a letter form stating operations performed and results obtained for each unit.

END OF SECTION

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SECTION 16000

ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY: Provide complete distribution systems for electrical power and lighting as shown on the drawings or required by other sections of these specifications.

A. Work includes, but is not necessarily limited to:
1. Install a new meter loop and meter combo base on a new dip pole with (2) 200 amp 2 pole load breakers per United Electric specification “M-8, 200 Amp, 3 Wire” United Electric to Install and connect to transformer. Power system shall be 240/120 volt (V), 60 Hertz (Hz), 1-phase, 3-wire.
2. Install underground cable from one of the two load breakers to the wet well control panel.
3. Installation of control panel, motor starters and controls, whether provided under this section or other sections of these specifications.
4. Grounding system.
5. Other items and services required to complete the electrical systems.

1.2 APPLICABLE PUBLICATIONS. Industry publications controlling the work of this Section include:

A. American Society for Testing and Materials (ASTM):
1. ASTM B8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

B. American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE):
1. 04.4 Methods Of Static Tests For Wood Poles
2. 05.1 Specifications And Dimensions For Wood Poles
3. 011.7 Specifications For Pentachlorophenol

C. National Electrical Manufacturer's Association (NEMA):
1. NEMA FU 1: Low Voltage Cartridge Fuses.
2. NEMA ICS: Motor Starters.

D. National Fire Protection Association (NFPA):
1. NFPA 70: National Electrical Code (NEC).
2. NFPA 78: Lightning Protection Code.
3. NFPA 101: Life Safety Code.
4. NFPA 110: Emergency and Standby Power Systems.

E. Occupational Safety and Health Administration (OSHA):
1. Occupational Safety and Health Standards.

F. F. Underwriters Laboratories Inc. (UL):

1.	UL 57:	Electric Lighting Fixtures.
2.	UL 96:	Lightning Protection Components.
3.	UL 96A:	Installation Requirements for Lightning Protection Systems.
4.	UL 98:	Enclosed and Dead-Front Switches.
5.	UL 198E:	Class R Fuses.
6.	UL 498:	Attachment Plugs and Receptacles.
7.	UL 943:	Ground-Fault Circuit Interrupters.
8.	UL 1449:	Standard for Safety, Transient Voltage Surge Suppressors, Revised Edition, July 1987.

1.3 SUBMITTALS. Submit the following in accordance with Division 1. Submittals are for the record or approval, as indicated.

A. Catalog cuts of safety switches for approval. Provide time-current characteristic curves for all fuses supplied.

B. Catalog cuts of grounding conductor, ground rods and connectors for the record.

C. Catalog cuts of power and control cable and connectors for the record.

D. Upon completion of this portion of the work, and as a condition of its acceptance, submit the following:

1. As-built drawings.

1.4 COORDINATION. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

PART 2 PART - PRODUCTS

2.1 MATERIALS AND EQUIPMENT.

A. Provide only materials that are new, of the type and quality specified, and free from defects and imperfections. Where Underwriters Laboratories Inc. has established standards for such materials, provide only materials bearing the UL label.

B. Manufacturers that can provide products meeting these specifications have been identified. Other manufacturers' products meeting these specifications may be acceptable subject to submittal of certificate of compliance, review, and approval. Where catalog numbers are shown, they should be

verified with the manufacturer to assure continued accuracy and compliance with these specifications.

C. All materials and equipment of the same type shall be made by the same manufacturer.

D. All materials and equipment shall be acceptable to the authority having jurisdiction as suitable for the use intended.

2.2 DISTRIBUTION.

A. Conduit, Fittings:
1. Rigid Galvanized Steel Conduit (RGS):
   a. Each length threaded on both ends.
   b. All scale, grease, dirt, burrs, and other foreign matter removed from inside and outside prior to application of coating materials.
   c. Galvanized by the hot-dip process as follows:
      1) Interior and exterior surfaces coated with a solid, unbroken layer of 99% virgin zinc by dipping.
      2) One coat of zinc chromate finish on inside and outside surfaces to prevent oxidation and white rust.
   d. Couplings and elbows fabricated, coated, and finished by the same process as conduit.
   e. Where conduits enter boxes or cabinets without threaded hubs, double locknuts shall be used plus a phenolic insulated metallic bushing on the open end.
2. Rigid Polyvinyl Chloride (PVC) Conduit:
   a. Fabricated from self-extinguishing, high-impact, polyvinyl chloride designed for above ground and underground installations.
   b. Type EPC, Schedule 40, heavy-wall rigid conduit, unless noted otherwise.
   c. Fittings and accessories fabricated from same material as conduit.
   d. Solvent-cement-type joints as recommended by manufacturer.
3. Flexible Liquid tight Metal Conduit:
   a. UL listed.
   b. Standard weight (36 lbs/100' minimum).
   c. Plastic coated galvanized zinc-coated steel.
   d. Fittings shall be designed for use with steel conduit.
4. Conduit clamps, straps and supports shall be steel or malleable iron.
5. Special Fittings: Conduit sealing, explosion-proof, dustproof, and other types of special fittings shall be provided as required. They shall be consistent with the area and equipment with which they are installed. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction. Hazardous area fittings shall conform to UL 886 and to NEC requirements for the area classification designated.

B. Wire and Cable:
1. Sizes indicated on the drawings.
2. Service-entrance cable shall have type RHW insulation.
3. Feeders and Branch Circuits:
   a. Flame-retardant, moisture- and heat-resistant thermoplastic with single conductor copper cable, Type THHN/THWN, 600V.
   b. Rated 75°C maximum conductor temperature in wet locations and 90°C in dry locations.

c. Conductor composed of 98% IACS, (International Annealed Copper Standards) soft annealed copper conforming to ASTM B8.
d. Conductor insulated with polyvinyl chloride to conform to or exceed Insulated Cable Engineers Association (ICEA) Standards.

4. Control Cable:
a. Use size 14.
b. Multiple-conductor shielded control cable, each conductor polyethylene insulated with a polyvinyl chloride covering and the cable having an overall polyvinyl chloride jacket.
c. Rated 600V, 90°C maximum conductor temperature in wet and dry locations.
d. Individual conductors composed of 98% IACS soft annealed copper, 7-wire stranded.
e. ICEA Method 1 color coding, colored insulation, and printed, colored tracers.
f. Provide plenum rated cable as required.

C. Connections to Equipment:
1. Power Cable Connectors:
a. For all wire, cable, equipment and bus terminals, designed and sized for the specific cable or bus being connected.
b. Solderless, pressure-type connectors constructed of high-strength, non-corrodible, tin-plated copper designed to furnish high-pullout strength and high-conductivity joints.
c. Rated current-carrying capacity equal to, or greater than, the cable being connected and with silver-plated contact surfaces for conductors of 500-kcmil copper capacity or greater.
2. Control Cable Connectors:
a. For control, alarm, and instrumentation wiring, use pre-insulated, diamond-grip type with ring tongue. Spade lugs will not be permitted.
b. Designed for the specific size and type conductor being used.

D. Wiring Devices:
1. GFCI Receptacles:
a. Rated 20A, 125 VAC, specification grade, NEMA 5-20R.
b. Flush-mounted, ivory color.
c. A contrasting color band on the reset button provides visible indication of a ground fault trip.
d. Duplex, arc-resistant and prewired, 3-wire, grounding-type.
e. Five milliampere trip level, feed-thru type, capable of protecting connected downstream receptacles.
f. Provide matching cover plates.
g. Weatherproof receptacles shall be supplied with a die cast aluminum, spring held cover with a rubber, watertight gasket.

E. Disconnects:
1. Provide safety switches of the heavy-duty type and rating as shown on the drawings or required for proper completion.
2. Safety Switches:
a. Provide heavy-duty, dead-front, positive, quick-make, quick-break, fused type or non-fused, as indicated on the drawings, rated 600 VAC for 480Y/277V system and 250 VAC for 240/120V system.
b. Switch shall be selected according to poles, amperes, volts and NEMA type enclosure as indicated on the drawings.
c. Unit shall be UL listed and externally operable with provision for padlocking.

d. Provide copper contacts in safety switches.
e. All switches shall have switch blades which are fully visible in the "OFF" position when the switch door is open.
f. The operating handle shall be an integral part of the box, not the cover. The handle position shall indicate whether the switch is "ON" or "OFF".
g. The covers shall be securable in the open position.
h. NEMA 3R switches shall have interchangeable, bolt-on hubs. Hub connections shall be watertight, dustproof, and airtight.
i. The finish shall be a baked enamel gray, electrodeposited on cleaned, phosphated steel.
j. Provide enclosures clearly marked for maximum voltage, current, horsepower rating, NEMA Type 3R, raintight.
k. Fuse clips for fusible units shall accommodate Class R fuses.
l. Sources: General Electric; Siemens; Square "D"; Westinghouse

3. Fuses:
   a. Fuses shall be Class RK1, dual element, current limiting, one-time fuse, 250V or 600V as required per NEMA FU1 and UL 198E.
   b. Interrupting rating shall be 200,000 amperes rms.
   c. Sources: Brush; Bussman
4. MOLDED-CASE CIRCUIT BREAKERS
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Eaton Electrical Inc.; Cutler-Hammer Business Unit.
      2) General Electric Company; GE Consumer & Industrial - Electrical Distribution.
      3) Siemens Energy & Automation, Inc.
      4) Square D; a brand of Schneider Electric.
   b. Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
   c. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   d. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
      1) Instantaneous trip.
      2) Long- and short-time pickup levels.
      3) Long- and short-time time adjustments.
      4) Ground-fault pickup level, time delay, and I2t response.
   e. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
   f. Features and Accessories:
      1) Standard frame sizes, trip ratings, and number of poles.
      2) Lugs: Suitable for number, size, trip ratings, and conductor material.
      3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Auxiliary Contacts: [One SPDT switch] [Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Alarm Switch: One [NO] [NC] contact that operates only when circuit breaker has tripped.

F. Motor Controllers:

1. Provide starters of the sizes and types needed for the operation as shown on the drawings, as specified herein, or as otherwise required for the operation of the facility. The starters shall include all required accessory items as well as thermal overloads in each ungrounded leg. Starters shall be horsepower rated, with interchangeable thermal overloads, and shall be equipped with reset devices operable from outside the starter enclosure.
2. Magnetic Starters:
   a. Full voltage, non-reversing or reversing as indicated, rated in accordance with NEMA standards, sizes and horsepower ratings.
   b. Three overload heaters in 3-phase units to match motor nameplate data for 480V, 3-phase, 60Hz.
   c. Built-in control transformer on units of adequate capacity for all control devices as indicated on wiring diagrams.
   d. Necessary auxiliary contacts required by means of starter or relay.
   e. Low voltage phase protection.
   f. Provide Hand-Off-Remote Switch.
   g. Auxiliary relay, 120 VAC contacts rated 6A up to 300V.
   h. Provide indicating lights.

3. Enclosure Requirements:
   a. Heavy-duty construction equipment with the following NEMA enclosures.

NEMA	Type of Service	Location
1	General Purpose	indoors or equivalent
3R	Weather Resistant	outdoors

   b. Phenolic nameplate on cover of each unit with wording as approved by engineer.

G. Supporting Devices:
1. Conduit or equipment supports shall be galvanized steel support channel adequate for the weight of equipment or conduit, including wiring, which they carry.
2. Fastening hardware shall be corrosion resistant.

H. Identification:
1. Identify all panel boards, motor controllers, transformers, cabinets, safety switches, transfer switches, and other apparatus used for operation and control of circuits, appliances, and equipment. Provide plastic laminate nameplates, white face with black core letters, showing proper identification. Minimum size nameplate shall be 1" x 3" with 1/4" letters. Labels shall be secured using silicone glue.
2. Wire and cable markers shall be type written vinyl self-laminating markers, which have a clear overlay of vinyl and an aggressive adhesive for adhesion to the wire.

I. Supporting Devices:
1. Conduit or equipment supports shall be galvanized steel support channel adequate for the weight of equipment or conduit, including wiring, which they carry.
2. Fastening hardware shall be corrosion resistant.

2.3 POWER SYSTEM.

A. Grounding:

1. Ground all power distribution equipment, branch circuit loads, etc. by conductor to the grounding system. All metallic parts of electrical equipment which do not carry current shall be grounded with an equipment grounding conductor whether or not shown on the drawings. The equipment grounding conductor shall be a green insulated copper conductor. Sizes of grounding conductors shall be in accordance with the NEC unless shown otherwise on drawings. The NEC shall govern and shall not be violated.
2. Ground Rods:
   a. Copper-clad steel or copper alloy, sectional type rods.
   b. One end pointed to facilitate driving.
   c. 3/4" diameter and 10'-0" long with diameter and length stamped near top of rod.
3. Connection Materials:
   a. Cable-to-cable, cable-to-rod, cable-to-connector, and cable-to-building steel connections of exothermic welding process, unless otherwise noted.
   b. Cable-to-equipment ground lugs:
      1) Bolted to equipment housing with silicon bronze bolts and lock washers.
      2) All equipment grounding shall be free of paint or any other material covering bare metal.
   c. Sources: Cadweld; OZ/Gedney; Weaver

2.4 LIGHTING SYSTEM.

A. Luminaires:

1. Provide all luminaires, lighting equipment, and components shown on the drawings, listed in the Fixture Schedule. Provide all labor and materials required to install specified equipment in the manner indicated.
2. All luminaires and lighting equipment shall be delivered complete with (as applicable) mounting accessories, sockets, holders, reflectors, ballasts, diffusing material, plaster frames, recessing boxes, etc., all wired and assembled as indicated.
3. All luminaires shall be rated, except as noted.

2.5 MISCELLANEOUS

A. The Contractor shall provide other materials, though not specifically described, which are required for a completely operational system and proper installation of the work.

PART 3 PART 3 - EXECUTION

3.1 LABOR AND WORKMANSHIP. All labor for the installation of materials and equipment furnished for the electrical system shall be done by experienced mechanics of the proper trades.

A. All electrical equipment furnished shall be adjusted, aligned and tested by the Contractor as required to produce the intended performance.

B. Upon completion of the work, thoroughly clean all exposed portions of the electrical installation, removing all traces of soil, labels, grease, oil, and other foreign material, and using only the type of cleaner recommended by the manufacturer for the item being cleaned.

3.2 COORDINATION. Coordinate as necessary with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

A. Coordinate the installation of electrical items with the schedule for work of other trades to prevent unnecessary delays in the total work.

B. Installation of exposed conduit, lighting fixtures, or other equipment shall not occur until all piping, pipe hangers, ducts and equipment which are above have been installed, and provided on site by others.

C. Where lighting fixtures and other electrical items are shown in conflict with locations of structural members, mechanical items, or other equipment, provide required supports and wiring to clear the encroachment.

D. Coordinate installation of Owner-furnished equipment and placement of conduits using vendor drawings, plans, and the established construction schedule.

E. Data indicated on the drawings and in these specifications are as exact as could be secured, but their absolute accuracy is not warranted. The exact locations, distances, levels, and other conditions will be governed by actual construction and the drawings and specifications should be used only for guidance in such regard.

F. Where outlets are not specifically located on the drawings, they shall be field located to the requirements of the NEC.

G. Verify all measurements at the building. No extra compensation will be allowed because of dimensional differences between the drawings and actual measurements at the site of construction.

H. The electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Where deviations are required to conform with actual construction and the work of other trades, make such deviations without additional cost to the Owner.

I. Perform trenching, bedding, and backfilling associated with the work of this Section in strict accordance with the provisions of Section 02320, EARTHWORK & TRENCHING, of these specifications.

3.3 INSTALLATION.

A. Conduits:
1. Install using as few joints as possible.
2. Provide RGS conduit for all conduit penetrating interior concrete walls and floors and for all exposed, exterior conduit.
3. Provide Schedule 40 PVC or RGS conduit below grade, unless noted otherwise. Minimum burial depth outside of building shall be 24" clear to top of conduit, unless noted otherwise.
4. Install flexible liquid tight metal conduit at all points of connection to equipment mounted on supports to allow for expansion and contraction or ease of maintenance.
5. The number of raceways shall be installed per drawings. Circuits shall not be combined to reduce number of raceways.
6. Where conduit has to be cut in the field, it shall be cut square with a pipe cutter using cutting knives.

7. All conduits shall be swabbed clean by pulling an appropriate size mandrel through the conduit before installation of wire or cable. Clear all blockages and remove burrs, dirt, and debris.
8. Provide insulated grounding bushings for all conduits stubbed into equipment enclosures.
9. Where conduit size is not indicated, install per NEC with a minimum size of 3/4" conduit.
10. Plugs shall be installed in all unused openings of all fittings, boxes, and panel boards.
11. Contractor is responsible for protecting all conduits during construction. Temporary openings in the conduit system shall be plugged or capped to prevent entrance of moisture or foreign matter. Contractor shall replace any conduits and/or ducts containing foreign materials that cannot be removed.

B. Conductors:

1. All wire shall be color coded as follows:

Description	208/120 Volt	480/277 Volt
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Grey
Ground	Green	Green

2. Single conductor and multi-conductor cable shall not be bent to radii smaller than that specified by the manufacturer or by the National Electrical Code. Special pull boxes or oversized conduits shall be used to meet this requirement.
3. Pulling lubricants shall be soapstone powder, powdered talc, or a commercial pulling compound. No soap suds, soap flakes, oil, or grease shall be used, as these may be harmful to cable insulation. Contractor shall use nylon or hemp rope for pulling cable to avoid scoring the conduit.
4. Cables shall be neatly trained, without interlacing, and be of sufficient length in all boxes, equipment panels, etc. to permit making a neat arrangement. Jackets of multi-conductor control cables shall be removed as required to properly train and terminate the conductors. Cables shall be secured in a manner to avoid tension on conductors or terminals, and shall be protected from mechanical injury and from moisture at the unprotected end. Sharp bends over conduit bushings are prohibited. Damaged cables shall be removed and replaced at the Contractor's expense.

C. Wiring Devices:
1. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of the NEC and NEMA standards and in accordance with recognized industry practices.
2. Coordinate with other work as necessary to interface installation of wiring devices.
3. At time of completion, replace those items that have been damaged, including those burned and scored by faulty plugs.

D. Grounding:
1. Install grounding system as shown on the drawings.
2. Install ground rods as indicated on the drawings, by driving and not by drilling or jetting.
3. Drive ground rods into unexcavated portion of the earth where possible.
4. Where ground rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.

5. Drive to a depth such that the top of ground rods will be approximately 12" below finish grade, or subgrade, and connect to counterpoise.
6. Conform to manufacturer's instructions for grounding system connections. All ground connections shall be inspected for tightness. Exothermic-welded connections shall be approved before being permanently concealed.
7. Chemically degrease and dry connections completely before welding.
8. Apply one coat of asphaltic coating to all exothermic-welded connections to be buried.
9. Make connections to equipment as follows:
   a. Make up clean and tight to assure a low-resistance connection with resistance drop not exceeding 1 ohm.
   b. Install so as not to be susceptible to mechanical damage during operation or maintenance of equipment.
   c. Provide direct copper connection to counterpoise.
10. A separate, continuous, insulated equipment grounding conductor shall be installed in all feeder and branch circuits.
11. A separate neutral conductor shall be installed for each branch circuit. Combining neutrals shall not be allowed.
12. Bond all insulated grounding bushings with a bare #6 AWG grounding conductor to a ground plate or ground bus.
13. Direct buried ground conductors shall be installed at a nominal depth of 30" below grade, unless noted otherwise.
14. All grounding conductors embedded in or penetrating concrete shall be insulated.

E. Control Panels:
1. Unless otherwise shown on the drawings, install control panel with the top of the trim 6'-3" above grade. Mount on channel as indicated.

F. Lighting Fixtures:
1. Completely install lighting fixtures for use and shall be located as shown on the drawings.
2. Wire fixtures with conductors which comply with paragraph - Wire and Cable.
3. Use only galvanized steel and galvanized hardware for fixture installation to provide protection against rust and corrosion.
4. All luminaires shall be aligned and lenses and diffusers cleaned at the completion of the work. Failed lamps shall be replaced.

G. Hazardous (Classified) Locations:
1. All work in hazardous locations shall be completed in accordance to the NEC and as shown on the drawings. In the case of conflicts, the contractor shall notify the engineer in writing and await for written instructions.
2. All conduit shall be rigid galvanized steel, equivalent to Schedule 40 pipe. EMT and IMC, as defined in the NEC, shall not be used.
3. Conduit sealing fittings shall be installed as required by the NEC.
4. Drain seals shall be installed on vertical conduits immedi¬ately before entering equipment enclosures in order to prevent moisture from entering equipment. Drains shall be used at all low points in the conduit systems and as required to prevent accumulation of moisture in conduit and equipment enclosures. All conduits passing through building walls shall be sealed within 18" of outside walls.
5. Conduit sealing fittings shall not be packed or poured until all systems have been inspected and tested.

3.4 ACCEPTANCE TESTING.

A. General:

1. Provide personnel and equipment, make required tests, and submit test reports upon completion of tests.
2. Provide temporary power source of proper type for testing purpose when normal supply is not available.
3. Make written notice to the Owner adequately in advance of each of the following stages of construction:
   a. In the underground condition prior to placing concrete floor slab, when all associated electrical work is in place.
   b. When all rough-in is complete, but not covered.
   c. After all exothermic-welded connections are made, but not concealed.
   d. At completion of the work of this section.
4. When material and/or workmanship is found not to comply with the specified requirements, the noncomplying items shall be removed from the jobsite and replaced with items complying with the specified requirements promptly after receipt of notice of such non-compliance.

B. Test Procedures:

1. All feeders shall have their insulation tested after installation, but before connection to devices. The conductors shall test free from short circuits and grounds.
2. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections.
3. After installation is complete, the equipment shall be demonstrated to operate satisfactorily and to conform to contract documents.
4. Measure and record voltages between phases and between phase wires and neutrals. Submit a report of maximum and minimum voltages.
5. Perform ground test to measure ground resistance of counterpoise. Resistance shall be 5 ohms or less.

C. System Functional Test:

1. Upon completion of equipment tests, a system functional test shall be performed. It is the intent of this test to prove the proper interaction of the power and control systems.

END OF SECTION

SECTION 16900

CONTROLS AND INSTRUMENTATION

PART 1 PART 1 GENERAL

1.1 SCOPE: Items not specified but which are essential to the proper operation, control, protection or which are customarily furnished by the contractor or manufacturers therewith, shall be furnished.

A. Work includes, but is not necessarily limited to:
1. Flow meter, and Floats, and mounting material, equipment, and installation.
2. Pump Control Panel. This panel shall contain the seal failure relays, thermal relays, and alternator. Indicating lights and additional relays and contacts shall be as required dependent on the equipment furnished.
3. Other items and services required to complete the control systems.

1.2 SEQUENCE OF OPERATION N/A

1.3 APPLICABLE PUBLICATIONS. Industry publications controlling the work of this Section include:

A. American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE):

ANSI/IEEE C37.90:	Surge Withstand (IEEE 472)
ANSI/IEEE C39.5:	Safety Requirements
ANSI/IEEE C39.6:	Digital Measuring Instruments
ANSI/IEEE S50.1:	Compatibility of Analog Signals for Electronic Industrial Process Instruments.

B. National Electrical Manufacturer's Association (NEMA):

NEMA FU 1:	Low Voltage Cartridge Fuses.
NEMA ICS:	Motor Starters.
NEMA WD 1:	Wiring Devices.

1.4 SUBMITTALS. Submit the following for approval.

A. Catalog cuts of all instrumentation.

B. Catalog cuts, panel layout, and wiring diagrams of the pump permissive panel

C. A system functional test procedure for use in system functional compliance testing.

D. Catalog cuts of the indicator lights, relays, panels and pump permissive panel layout.

E. Upon completion of this portion of the work, and as a condition of its acceptance, submit the following:
   1. As-built drawings.
   2. Copies of all warranties and guarantees.

F. Upon completion of this portion of the work, and as a condition of its acceptance, submit operation and maintenance manuals. Include within each manual:
   1. Copy of the Record Documents for this portion of the work.
   2. Copies of all warranties and guarantees.
   3. Emergency instructions.
   4. Spare parts list.
   5. Wiring diagrams.
   6. Shop drawings and product data.
   7. Include the following information for equipment items:
      a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
      b. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.
      c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

1.5 COORDINATION. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

1.6 SPARE PARTS. Provide the following spare parts for each type of material specified:

A. Fuses - 3 of each type used

B. Indication Light Bulbs - 100%

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT.

A. Provide only materials that are new, of the type and quality specified, and free from defects and imperfections. Where Underwriters Laboratories Inc. has established standards for such materials, provide only materials bearing the UL label.

B. All materials and equipment of the same type shall be made by the same manufacturer.

C. All materials and equipment shall be acceptable to the authority having jurisdiction as suitable for the use intended.

2.2 PANELS

A. Wiring:

1. Alpha or Belden 600V, 105°C, UL style 1015 wire or Houston Wire and Cable SI-57275, SIS, or Engineer approved equal. DC signal wiring shall be as specified in this Division.
2. NEC type THHN wire, rated 90°C at 600V. DC signal wiring shall be as specified in this Division.
3. Wire Sizes:
   a. No. 12 AWG for all convenience outlets, interior lighting, and other similar loads.
   b. No. 16 or 18 AWG, 16- to 41-strand, for low power loads of 115V or lower voltage.
4. Wire Markers:
   a. Wire and cable markers shall be type written vinyl self laminating markers, which have a clear overlay of vinyl and an aggressive adhesive for adhesion to the wire, as manufactured by Brady or engineer approved equal.
   b. Identify both ends of wire with the same unique wire number as indicated on the drawings.
   c. Assign wire numbers where specific designations are not indicated.
   d. Hand written adhesive markers shall not be accepted
5. Wiring Methods:
   a. Route main groups of wires in plastic nonflammable wiring duct.
   b. Smaller groups of wire shall be cabled and secured with nylon cable clamps and ties or plastic spiral wraps.
   c. Route instrument dc signal wiring in separate ducts or groups from ac power and control wiring.
   d. Equipment and Terminal Block Connections:
      1) Install terminals with tool as recommended by manufacturer to apply required amount of pressure correctly.
   e. Solder Connections: Soldering iron used shall not exceed 100 W.
   f. Provide terminal blocks for all external connections.
   g. Identification:
      1) Identify all apparatus used for operation and control of circuits, appliances, and equipment. Provide plastic laminate nameplates, black face with white core letters, showing proper identification. Minimum size nameplate shall be 1" x 3" with 1/4" letters. Labels shall be secured using silicone glue.
      2) Wire and cable markers shall be machine printed vinyl markers, shrink wrap type for all cables and wires. All wires shall be identified with the circuit numbers as shown on the drawings and construction record documents (as-constructed). Hand written adhesive markers will not be acceptable.

B. Power Terminal Blocks:
   1. 600V, sectional type phenolic or polypropylene blocks.
   2. Tubular clamp contacts.
   3. Slide-in vinyl marking strip for terminal identification.
   4. Provide a minimum of 10% spare terminals.

C. Switch Action Fuse Blocks:
   1. Rated 600V, 30-A.
   2. Sectional type nylon or polypropylene blocks.
   3. Strap screw contacts or tubular clamp contacts.
   4. Pressure sensitive marking tape for terminal identifications.

D. Circuit Breakers:
   1. Low voltage:
      a. AB-1489 for each instrument system, or Engineer approved equal for annunciator, lighting circuit, control system or similar major device requiring 24 or 115Vac power.
      b. AB 1492-D, or Engineer approved equal for devices or systems requiring 26V, dc power.
      c. Trip rating as indicated or recommended by manufacturer of equipment being protected.
      d. Necessary space on panel for a minimum of three future circuit breakers.
      e. Mounted on a panel inside control panel in a readily accessible location.
   2. 600 Volt Rated:
      a. Provide main breaker, as indicated..
      b. Branch breakers shall be thermal-magnetic (non-interchangeable) circuit breakers of sizes noted, and rated in accordance with the panels.
      c. 22,000 AIC rated.

E. General-Purpose Control Relays:
   1. Potter & Brumfield Series KRP, Struthers-Dunn Series 219 or Engineer approved equal.
   2. Provide with coil voltage as indicated with a coil energization indicator.
   3. Number of contacts required rated at 10-A at 120Vac.
   4. Provide plug-in relay with socket.

F. Pilot Lights:
   1. Shall be UL and NEMA Type 4X.
   2. LED Full voltage type.
   3. Color caps as indicated.

G. Selector Switches:
   1. The switch arrangement and legend plate shall be as indicated.
   2. Shall be UL and NEMA Type 4X.
   3. Source: Class 9001 Type SK-30.5 mm as manufactured by Square D or engineer approved equal.

H. Control Circuit Transformer: (if required)
   1. Shall include internal primary protection and one secondary fuse (in the non-ground secondary conductor).
   2. The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads.

I. Elapsed Time Meters: The elapsed time meters shall be mounted inside the enclosure.
   1. Non resettable.
   2. Panel mounted.

J. Level or Flow Indicators:
   1. LED Readout.
   2. Panel mounted.
   3. 4-20 ma signal.

K. Alternator: Provide a two pump alternator. The unit shall function as described on the drawings. A switch shall be set to alternate the pumps or lock the relay. Manufactured by Time Mark, Automation Direct, SSAC, or engineer approved equal.

L. Enclosure:
   1. Shall be a NEMA 4x - stainless steel

M. Terminal Strips:
   1. Provide all end caps, clamps, dividers, terminal numbers, DIN rails, and any other items necessary to provide the terminal strip assemblies. Within each terminal strip the terminals shall be numbered consecutively. All terminal strips shall be 5 mm polyamide type similar to the Phoenix contact UK series, Weidmueller W Series or Engineer approved equal.

N. Lightning arrester: A lightning arrester shall be connected to the incoming power terminals. Arrester shall be U.L. listed, and CSA Certified, rated 650 volts AC to ground for voltage and phase for the pump, 3-wire services. Arrester shall be mounted on exterior of cabinet. Square D “SDSA 1175" for single phase applications, and “SDSA 3650" for three-phase applications, or equal.

O. Phase monitor: Provide an under voltage and an overvoltage for single phase pump station. Power monitor shall be a panel-mounted unit designed to continuously monitor the single-phase, voltage as applicable, 60 Hz power source for abnormal conditions.

P. Ground fault circuit interrupter: A ground fault circuit interrupting receptacle shall be mounted flush with the side of the pedestal enclosure, to provide 120 VAC power for maintenance personnel at each lift station site. GFCI receptacle shall be U.L. listed, meet U.L. class A tripping requirements, and have a NEMA 5-15R configuration. GFCI receptacle shall have a test/reset button.

Q. Alarm beacon: Alarm beacon shall be a U.L. listed, weatherproof 120 VAC, flashing LED beacon light with a red colored shatter resistant acrylic lens. Flash rate shall be 60 to 80 flashes per minute. Beacon lamp shall be LED, .097 amps, rated at 100,000 hours. Alarm beacon shall be suitable for mounting on ½" rigid galvanized steel conduit.

R. Mounting of Relays and Control Devices:
   1. Complete accessibility to all terminals, relay sockets, and other devices without dismantling of panel equipment.
   2. Do not block access to any instruments or control devices mounted on face sheet.
   3. Installed on swing-out panels if necessary.
   4. Mount all diodes, resistors and similar equipment between terminal points on terminal blocks.
   5. Mount instrumentation as specified in Section 16000.

S. All equipment and devices shall be rated for operation in an ambient temperature range of -20° to +140° F.

T. Seal Leak and Overtemp Relay: Relay shall monitor both motor and bearing over-temperature and seal-failure in a single plug-in unit. In an alert condition, the appropriate LED is illuminated and relay contacts associated with the condition toggle. A Test push button simulates faults on both sensor channels, and a Reset push button clears the alert indicators after (1) The Test push button has been depressed, or (2) an actual alert has been corrected. The Reset push button performs a "hard" microprocessor reset. Auto/Manual Reset: Channels that monitor temperature can be set for Manual or Auto reset after experiencing an alarm condition. (Seal failures automatically reset when the alarm condition is removed although the LED continues to flash until reset.) Reset Push-button: The reset button is used to reset all alarm conditions and clear flashing LED states. Test Push-button: The test button simulates an alarm condition in both channels until released. NOTE: In many cases this will cause the pump to stop because of the simulated high temperature condition. As manufactured by HOMA , MTS, Diversified Electronics, or Engineer approved equal.

U. See Section 16000 for Motor Controllers.

2.3 FLOATS

A. Floats shall be a stainless steel mercury tilt type with NO or NC contacts and SO cable length as required. Model 9G as manufactured by Consolidated Electric or engineer approved equal.

2.4 ELECTROMAGNETIC FLOWMETER

A. Provide electromagnetic flow meters as indicated on the Drawings, complete with signal converter, cables, and other accessories required for a complete and functional installation. The Flow Converter shall be a MJK “MagFlux 297926” with the “MagFlux 297222” flow sensor, and the “MagFlux 69180” sensor cable. The Flowmeter shall be mounted in a vault separate from the wet well as indicated on the Drawings. The signal converter shall be mounted next to the control panel as indicated and wired to a source of control power.

B. Equalization of sensor potential shall be accomplished effectively and completely. If necessary, a grounding flange shall be furnished, installed, and properly grounded and bonded.

PART 3 PART 3 EXECUTION

3.1 LABOR AND WORKMANSHIP. All labor for the installation of materials and equipment furnished for the electrical system shall be done by experienced workman of the proper trades.

A. All electrical equipment furnished shall be adjusted, aligned and tested by the Contractor as required to produce the intended performance.

B. Upon completion of the work, thoroughly clean all exposed portions of the electrical installation, removing all traces of soil, labels, grease, oil, and other foreign material, and using only the type of cleaner recommended by the manufacturer for the item being cleaned.

3.2 COORDINATION. Coordinate as necessary with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

A. Coordinate the installation of electrical items with the schedule for work of other trades to prevent unnecessary delays in the total work.

B. Data indicated on the drawings and in these specifications are as exact as could be secured, but their absolute accuracy is not warranted. The exact locations, distances, levels, and other conditions will be governed by actual construction and the drawings and specifications should be used only for guidance in such regard.

C. Verify all measurements at the job sites. No extra compensation will be allowed because of dimensional differences between the drawings and actual measurements at the site of construction.

D. The electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Where deviations are required to conform with actual construction and the work of other trades, make such deviations without additional cost to the Owner.

3.3 INSTALLATION. All installation practices shall be in accordance with the listed codes, standards, and manufacturer’s recommendations.

3.4 ACCEPTANCE TESTING.

A. General:
   1. Provide temporary power source of proper type for testing purpose when normal supply is not available.
   2. When material and/or workmanship is found not to comply with the specified requirements, the noncomplying items shall be removed from the job site and replaced with items complying with the specified requirements promptly after receipt of notice of such non-compliance.

B. Test Procedures:
   1. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections.
   2. The control and instrumentation circuits shall be demonstrated to operate satisfactorily and to conform to contract documents.

C. System Functional Test:
   1. Upon completion of equipment tests, a system functional test shall be performed.

END OF SECTION