MoDOT

I-29 REST AREA SEWER IMPROVEMENTS

DEARBORN, MISSOURI

APRIL 2013

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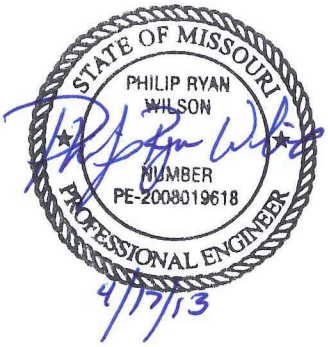
(Sign & Seal)

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: 4/17/13

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, 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: Dale K. Dickson Date: 4/16/13

Name: Dale K. Dickson

Missouri License No.: E-23058

My license renewal date is December 31, 2014.

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

END OF DOCUMENT 00005

TECHNICAL SPECIFICATIONS

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END OF DOCUMENT

SECTION 01010
SUMMARY OF WORK

1PART GENERAL

1.1 SECTION INCLUDES

A. Contract Description.

B. Contractor use of site and premises.

C. Work Sequence.

D. Owner operations.

1.2 CONTRACT DESCRIPTION

A. Contract Type: Unit price as described in the Agreement.

B. Work under this contract will include but is not limited to:

The project consists of the construction of approximately 20,500 feet of 3" PVC SDR-21 forcemain with a Duplex lift station, valve pit, electricity, two creek crossings and all necessary appurtenances. Contractor will also be responsible for obtaining the road crossing permit from the County.

1.3 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to owner's property, public right of way or project easements.

1.4 WORK SEQUENCE

A. The work sequence is to be determined by the Contractor, except that all existing utilities shall remain in operation until the new construction has been tested and accepted. Cleanup work shall progress at the same rate as construction of new utilities. Contractor shall submit proposed sequence of work to Engineer for approval prior to commencement of construction.

2PART SEPARATION OF WATER AND SEWER UTILITIES

2.1 GENERAL: The following factors should be considered in providing adequate separation:

A. Materials and type of joints for water and sewer pipes

B. Soil conditions

C. Service and branch connections into the water main and sewer line

D. Compensating variations in the horizontal and vertical separations

E. Space for repair and alterations of water and sewer pipes; and

F. Off-setting of water mains around manholes.

2.2 PARALLEL INSTALLATION:

A. Water mains shall be laid at least ten feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten-foot separation, the Department of Natural Resources may allow deviation on a case-by case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer and in either case, at such an elevation that the bottom of the water main is at least 18 inches above the sewer. In areas where the recommended separations cannot be obtained, either the waterline or the sewer line shall be constructed of mechanical joint pipe or cased in a continuous casing.

2.3 CROSSINGS:

A. Water mains crossing sewers shall be laid to provide a minimum Vertical clear distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. At crossings, the full length of water pipe shall be located so both joints will be as far from the sewer as possible but in no case less than ten feet. Special structural support for the water and sewer pipes may be required. In area where the recommended separations cannot be obtained either the waterline or the sewerline shall be constructed of mechanical joint pipe or cased in a continuous casing that extends no less than ten feet on both sides of the crossing.

2.4 EXCEPTION:

A. Any variance from the specified separation distances in paragraphs B and C must be submitted to the Department of Natural Resources for approval.

2.5 FORCE MAINS:

A. There shall be at least a ten-foot horizontal separation between water mains

and sanitary sewer force mains and they shall be in separate trenches. In areas where these separations cannot be obtained, either the waterline or the sewer line shall be cased in a continuous casing.

2.6 SEWER MANHOLES:

A. No waterline shall be located closer than ten feet to any part of a sanitary or combined sewer manhole.

2.7 DISPOSAL FACILITIES:

A. No waterline shall be located closer than 25 feet to any on-site wastewater disposal facility, agricultural waste disposal facility, or landfill.

3PART PRODUCTS

Not Used.

4PART EXECUTION

Not Used.

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

1PART GENERAL

1.1 SECTION INCLUDES

A. Coordination and project conditions.

B. Preconstruction meeting.

C. Monthly progress meeting.

1.2 COORDINATION AND PROJECT CONDITIONS

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

B. Coordinate completion and clean-up of Work of separate sections in preparation for Project Completion.

1.3 PRECONSTRUCTION MEETING

A. Engineer will schedule a meeting after Notice of Award.

B. Attendance Required: Owner, Engineer and Contractor.

C. Agenda:
1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of Subcontractors, list of Products, and progress schedule.
5. Designation of personnel representing the parties in Contract, and the Engineer.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Scheduling.
8. Resident Inspector’s notes and comments.

1.4 MONTHLY PROGRESS MEETING

Meeting Dates will be set at the Preconstruction Conference.

Attendance Required: Owner, Engineer, and Contractor.

Agenda

Review of Progress.
Review of Contractors Schedule/30 day projection.
Owner/Engineer Comments.
Delays.
Submittals.
Material Delivery.
Application for Payment.
Changes in Work.
Record Drawing Update.
Pay Estimate Approval.

2PART PRODUCTS

Not Used

3PART EXECUTION

Not Used.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Proposed Products list.

C. Product Data.

D. Shop Drawings.

E. Certificates.

F. Manufacturer's instructions.

G. Preconstruction photographs.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals:

B. Section 01400 - Quality Control:

C. Section 01700 - Contract Closeout: Contract bonds, manufacturers' certificates, and closeout submittals.

1.3 REFERENCES

A. AGC (Associated General Contractors of America) publication "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".

1.4 SUBMITTAL PROCEDURES

A. Transmit each submittal with Engineer acceptance form.

B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.

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.

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

F. For each submittal for review, allow 15 days excluding delivery time to and from the contractor.

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

H. Provide space for Contractor and Engineer review stamps.

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

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

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

1.5 PROPOSED PRODUCTS LIST

A. Within 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.

1.6 PRODUCT DATA

A. Product Data For Review:
   1. Submitted to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

   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 the Engineer's knowledge as contract administrator or for the Owner.

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

D. Submit the number of copies which the Contractor requires, plus three copies which will be retained by the Engineer.

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.

1.7 SHOP DRAWINGS

A. Shop Drawings For Review:
   1. Submitted to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
   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 the Engineer's knowledge as contract administrator or for the Owner.

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

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

1.8 CERTIFICATES

A. When specified in individual specification sections, submit certification by the manufacturer, installation/application subcontractor, or the 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.

1.9 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, to Engineer for delivery to owner in quantities specified for Product Data.

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

C. Refer to Section 01400 - Quality Control, Manufacturers' Field Services article.

1.10 PRECONSTRUCTION PHOTOGRAPHS

A. Two prints, 3"x 5", Color, mounted on 8½”x 11" album, labeled with area included in photograph and a video tape of a walk through along the alignment of the proposed sewer mains.

B. Take adequate photos of all features prior to start of construction in each area.

C. Identify photos with date, orientation, and project identification.

D. Payment for photos is incidental to other items of work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 REQUIRED SUBMITTALS

A. Contractor shall submit the following information for materials and equipment to be provided under this contract.

B. Legend:

CODE	TYPE OF SUBMITTAL
1	Shop Drawings
2	Product Data
3	Sample
4	Certifications
5	Manufacturer's Instructions
6	Test Report
7	Inspection Report
8	Wiring Diagram
9	Record Photographs
10	Maintenance Data
11	Operating Instructions
12	Warranty

C. List of required submittals:

SECTION	DESCRIPTION	CODE
01010	Summary of Work	9
02220	Earthwork and Trenching	4, 6
02730	Sewage Piping Systems	2, 4, 5
02738	Manholes and Covers	1, 2, 4, 5
02920	Lawns & Grasses	2, 4
03100	Concrete Form Work	1, 2
03200	Concrete Reinforcement	1, 2, 4, 6
03300	Cast-In-Place Concrete	2, 4, 6
11307	Submersible Grinder Pump Station	1, 2, 4, 5, 6
11600	Hoists & Cranes	1, 2, 4, 5, 11, 12
16000	Basic Electrical Materials & Methods	1, 2, 4, 5, 8, 10, 11, 12
16483	Adjustable Frequency Drives	1, 2, 4, 5, 8, 10, 11, 12
16900	Controls & Instrumentation	1, 2, 4, 5, 8, 10, 11, 12

END OF SECTION

SECTION 01400

QUALITY CONTROL

1PART GENERAL

1.1 SECTION INCLUDES

A. Quality assurance - control of installation.

B. References and standards.

C. Tolerances

1.2 RELATED SECTIONS

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

B. Section 01600 - Material and Equipment: Requirements for material and product quality.

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.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.4 TOLERANCES

A. Monitor fabrication and installation tolerance control of Products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust Products to appropriate dimensions; position before securing Products in place.

1.5 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 the Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

2PART PRODUCTS - Not Used.

PART 3 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.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1PART GENERAL

1.1 SECTION INCLUDES

A. Temporary Sanitary Facilities.

B. Barriers

C. Protection of Work.

D Progress Cleaning & Waste Removal

E. Removal of Utilities

1.2 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.

1.3 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas specifically any areas that present a potential hazard to the general public, to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

1.4 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.

1.5 PROGRESS CLEANING AND WASTE REMOVAL

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

B. Collect and remove waste materials, debris, and rubbish from site periodically and dispose off-site at an approved facility.

1.6 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

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

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

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

2PART PRODUCTS

Not Used.

3PART EXECUTION

Not Used.

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

1PART GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Transportation and handling.

C. Storage and protection.

D. Product options.

E. Substitutions.

1.2 RELATED SECTIONS

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

B. Section 01400 - Quality Control: Product quality monitoring.

1.3 PRODUCTS

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

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

B. Store with seals and labels intact and legible.

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

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

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

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

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

1.6 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.

1.7 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions only within 15 days after date established in Notice to Proceed.

B. Substitutions may be considered when a Product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. 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 Engineer for review or redesign services associated with re-approval by authorities.

E. 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.

F. Substitution Submittal Procedure:
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.

2PART PRODUCTS

Not Used.

3PART EXECUTION

Not Used.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

1PART GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Adjusting.

D. Project record documents.

1.2 RELATED SECTIONS

A. Section 01500 - Construction Facilities and Temporary Controls: Progress cleaning.

1.3 CLOSEOUT PROCEDURES

A. Contractor to notify Engineer for scheduling of a Pre-Final Inspection.

B. 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.

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

1.4 ACCEPTANCE OF FINAL PAYMENT AS RELEASE

The acceptance by the Contractor of final payment shall be and shall operate as a release to the Owner of all claims and all liability to the Contractor other than claims in stated amounts as may be specifically accepted by the contractor for all things done or furnished in connection with this work. Any payment, however final or otherwise, shall not release the Contractor or its sureties from any obligations under the Contact Documents or the Performance and Payment Bonds.

1.5 WARRANTY OF WORK

The contractor shall warrant all materials and equipment furnished and work performed for a period of one (1) year from the date of completion and acceptance of the work. The contractor warrants and guarantees for a period of one (1) year from the date of completion and acceptance of the work that the completed work is free from all defects due to faulty materials or workmanship and the CONTRACTOR shall promptly make such corrections as may be necessary by reason of such defects including the repairs of any other damages that were caused by defects in the work. The owner will give notice of observed defects with reasonable promptness. In the event that the contractor should fail to make such repairs, adjustments, or other work that may be necessary by such defects, the owner may do so and charge the contractor the cost hereby incurred. In emergency where, in the judgement of the owner, delay would cause serious loss or damage, repairs and replacement of defects in the work and damage caused by the defects may be made without notice being sent to the contractor, and the contractor shall pay the cost thereof. The Performance Bond shall remain in full force and effect through the warranty period.

1.6 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

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

1.7 ADJUSTING

C. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.8 PROJECT RECORD DOCUMENTS

D. 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 instruction for assembly, installation, and adjusting.

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

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

G. Record information concurrent with construction progress.

H. 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.

I. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Details not on original Contract drawings.

J. Submit documents to Engineer with claim for final Application for Payment.
   1. Contractor shall record and submit to Engineer with final payment application records of all service connections.
   2. Contractor will be responsible for providing the “as-built” drawings.

2PART PRODUCTS

Not Used.

3PART EXECUTION

Not Used.

END OF SECTION

SECTION 02205

TEMPORARY EROSION & SEDIMENT CONTROL

1PART GENERAL:

1.0 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.

2 PART 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.

3 PART 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:

3.2.1 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.

3.2.2 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.

3.2.3 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.

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

3.2.5 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:

3.4.1 General: The contractor shall install a temporary silt fence as shown on the plans, and at other locations as directed by the engineer. 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.

3.4.2 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.

3.4.3 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.

3.4.4 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.

3.4.5 Removal: The silt fence shall remain in place until the engineer directs that it be removed. 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.

3.4.6 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[2]	90 Minimum[2]
Elongation at 50% Minimum tensile strength. (45 Lbs.)	ASTM D4632	N/A	50 Maximum
Filtering 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 D 4355	Minimum 70% Strength Retained	Minimum 70% Strength Retained

Note:

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

4 PART SUBMITTALS:

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

Geotextile Fabric

END OF SECTION

SECTION 02220

EARTHWORK AND TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Disposal of materials.

2. Tree removal.

3. Site clearing and preparation.

4. Excavation.

5. Construction of fills and embankments.

6. Trenching.

7. Pipe embedment requirements and schedule.

8. Backfilling.

B. The Contractor shall perform investigations, before bidding, as he considers necessary to satisfy himself as to the materials to be encountered. He shall then submit his bid to include the removal of any and all material. 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 RELATED SECTIONS

A. Section 02730 - Sewage Piping Systems

B. Section 02738 - Manholes and Covers

C. Section 02920 - Lawns and Grasses

D. Appendix A – Geotechnical Report Boring Logs

1.3 REFERENCES

A. The following publications form a part of these specifications to the extent indicated by references thereto. Only the most recent revisions of these publications shall be used.

1. ASTM D-698 Moisture-Density Relations Of Soils, Using 5.5 Pound (2.5 kg) Rammer And 12-Inch (304.8 mm) Drop

2. ASTM D-1140 Test Method for Amount of Material in Soils Finer Than the No. 200 (75µm) Sieve.

3. ASTM D-2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D-3017 Standard Test Methods for Water Content of Soil and Rock by Nuclear Methods.

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

1.4 SUBMITTALS

A. The Contractor shall submit the following items, in accordance with Section 1300:

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

1.5 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 in the respective pipe section.

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, to replace excavated material below existing grade.

1.6 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 Supplemental General Conditions, 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

A. Granular Embedment Material: Embedment material shall be a ¾" crushed stone with at least 95% of the material passing the ¾" square sieve and no more than 5% passing a # 4 sieve.

2.3 COMPACTED CRUSHED STONE: Crushed stone shall be as specified for pipe embedment material.

2.4 FILL MATERIALS

A. Bulk Fill Material: Bulk fill material for earthfills and embankments 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. Bulk fill material shall be imported if suitable soil material is not available on site.

B. Random Backfill Material: Random backfill material for pipe and utility trenches shall be job-excavated soil material which is free from organic material, debris, and rocks or lumps larger than 6 inches in their greatest dimension.

C. Select Fill Material: Select backfill material shall be a sorted, job-excavated or imported soil material as specified for bulk fill material, except no rocks, stones, or lumps larger than one inch in largest dimension shall be present.

D. Granular Backfill Material: Granular backfill material shall be a graded gravel or crushed stone 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	4 - 8

1. Granular backfill 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.

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, Inc. " 1-(800) DIG-RITE. 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 and identify utilities that remain and protect them 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. 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. No separate payment will be made for rock.

3.3 SITE CLEARING:

A. 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 in accordance with the stipulations of Section 02220. 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.

B. Clearing and stripping: All vegetation and other unsuitable material, or other miscellaneous debris occurring within the limits of the excavation and site grading shall be removed as part of the clearing operations and disposed of by, and at the expense of, the Contractor. Likewise, six inches of topsoil shall be stripped from the disturbed construction areas and stockpiled for later use in final grading.

C. Tree Removal: It is the intent of these specifications to minimize tree removal.

1. No trees except for those designated for removal on the drawings are to be damaged or removed without the express approval of the Owner.

2. All trees, brush, etc., shall be disposed of by the Contractor as specified herein.

3. Trees shall be removed in such a manner that will prevent damage

to trees left standing, to existing structures, utilities, paved roadways, curbs and walkways, and with due regard to the safety of employees and others.

4. Surfaces of trees that are cut or scarred by the Contractor's operations shall be painted with an approved asphaltum base paint prepared especially for tree surgery.

3.4 EARTHFILLS AND EMBANKMENTS

A. Material and Compaction Requirements:

1. Fill areas which are below an envelope defined as being within 5 horizontal feet of a structure or concrete slab shall be filled with select backfill material, as specified herein, unless otherwise indicated on the Drawings. The select backfill material shall be placed in lifts not exceeding 8 inches loose thickness, and 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.

2. Fill areas which are outside the envelope described above shall be filled with bulk fill material, as specified herein, unless otherwise indicated on the Drawings. The bulk backfill material shall be placed in lifts not exceeding 8 inches loose thickness, and shall be compacted to a minimum 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.

a) For areas which will be surfaced with gravel, the top two feet of bulk fill shall be compacted to a minimum of 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.

B. All unstable or unsuitable material shall be removed from the existing surface to receive fill material prior to commencing embankment work.

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 or backfill 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 insure 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 in the remainder of fills and embankments, provided they are distributed so they do not interfere with proper compaction, as determined by the Engineer.

3.5 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.

a) 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 compacted.

2. Excavation below structure or trench subgrade:

   a) Over excavation due to Contractor's oversight shall be backfilled with granular embedment material placed in 8-inch loose lifts and compacted to 90 percent of the maximum density for that material in accordance with ASTM D-698, at no additional cost to the Owner.

   b) When unstable or unsuitable material is encountered in the subgrade, such material shall be removed, backfilled with granular pipe embedment material and compacted to the density equal to or greater than required for subsequent backfill material. Such excavation and backfill shall be done at no additional cost to Owner.

   c) 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 granular embedment material as required by the Engineer to assure a firm foundation. Such excavation and backfill shall be done at no additional cost to Owner.

   d) Where granular embedment material is not available, and in locations directed by the Engineer, granular backfill material shall be used to stabilize or raise the subgrade.

3. No blasting of any kind for rock excavation or for other purposes will be permitted unless permission is given in writing from the Owner.

4. Dewatering: Each excavation shall be kept dry by Contractor 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 groudwater 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 do not have to work in mud or water. 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 and unsuitable material, not being reused, from site.

3. Compacted crushed stone shall be placed beneath concrete slabs and in other locations indicated on the Drawings. Crushed stone shall be placed in 6" loose lifts and compacted to 90% of maximum dry density as determined by ASTM D-698, at a moisture content within plus or minus 3 percent of optimum.

C. Trenching:

1. All pipeline excavation shall be open cut unless shown otherwise on the plans. 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 from collapse.

2. Trenches shall be excavated within the limits of public right-of-way or easements 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. One city block or 300 feet, whichever is the shorter, shall be the maximum allowable length of open trench ahead of pipe laying.

5. Trenches shall be excavated to a width which will provide adequate working space and pipe clearances for proper pipe installation,, jointing, and embedment. However, 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	35
15	30	6	38
18	34	6	42
21	39	7	48
24	43	7	52
27	48	8	57

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. Excessively large trench widths in roads shall not be compensated for extra pavement restoration outside prescribed trench widths.

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.

11. Topsoil displaced due to trenching shall be carefully stockpiled and placed back on top of the trench when backfilling.

3.6 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. 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.

3.7 PIPE EMBEDMENT

A. Embedment Classes: Embedment classes shall be as follows, and as detailed on the Drawings. All lifts are given in loose thickness. All compaction percentages refer to maximum dry density as determined by ASTM D-698. Select backfill material shall be compacted within 2% of optimum moisture content.

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 section 03300. 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 section 03300. After the initial set of the concrete, granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%, up to the top of pipe. One foot of select backfill material shall be placed above the top of pipe, placed in 8-inch thick, loose lifts and compacted 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 backfill 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 backfill material extending from the bottom of the pipe to above the top of 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 Section 03300, for 3000 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	6"	B-1
SDR-PR PVC	6"	D
C-900 PVC	6"	D
DIP (ductile iron)	6"	B-2
Other types not listed here	6"	B-1

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.

3.8 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 covered or frozen.

5. No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum compressive strength of 2000 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, or in areas which have or will have a paved or chip-and-seal surface, or where indicated on the drawings to use granular backfill material:

    a. Granular backfill material shall be placed on the compacted pipe embedment, in layers not to exceed 9 inches loose thickness and compacted.

    b. Granular backfill material shall be compacted by vibratory means. Each lift of granular backfill material 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 9 inches in loose thickness and compacted.

    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. Random 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 backfill material shall be placed on the compacted pipe embedment, in layers not to exceed 9 inches in loose thickness and compacted.

    b. Random backfill 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 plus 3 or minus 3 percent of optimum. Random 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, bull-dozed 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 for structures within paved or graveled areas shall be granular backfill 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 backfill shall be placed in lifts not to exceed 8 inches in loose thickness, and compacted by careful pneumatic or vibratory tamping.

3. Structure backfill for structures in other areas shall be select fill material, placed in lifts not to exceed 9 inches in loose 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.

3.9 SURFACE RESTORATION

A. All areas disturbed by construction operations shall be restored by paving, gravel surfacing, seeding, or sodding as indicated on the Drawings and specified.

3.10 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 loose lifts of 8 inches in thickness and compacted to 95% of maximum density as determined by ASTM D698. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.

3.11 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.

3.12 SOIL TESTING: The Contractor shall provide for sampling and testing of all trench backfills and material for impervious trench checks:

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 test results on materials which are imported (not job excavated) shall be 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 200 cubic yards of job excavated backfill.

B. Field Tests:

1. During the progress of the work of filling and backfilling, in-place density tests shall 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 300 cubic yards of fill/backfill and two (2) tests per 500 feet of trench shall be taken unless otherwise directed by the Engineer. One additional test shall be performed on each trench check. One additional test shall be taken at driveway or roadway crossing that is disturbed by open cut.

3. If the tests indicate the compaction is not sufficient, the Contractor shall increase the compactive effort on all such inadequately compacted areas.

C. Compensation:

1. All costs for testing shall be performed by the Contractor at the Contractor's expense.

2. Contractor to use an independent Lab approved by the Engineer for Soil Testing.

END OF SECTION

SECTION 02730

SEWAGE PIPING SYSTEMS

1PART GENERAL

1.1 SUMMARY

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

B. Section Includes:

1. Sanitary gravity sewer and force main piping, fittings, and accessories.

2. Gravity sewer acceptance testing.

3. Force main/pressure sewer/pressure piping acceptance testing.

1.2 RELATED SECTIONS:

A. Section 02220 - Earthwork and Trenching for trenching, embedment, and backfill.

B. Section 02738 - Manholes and Covers.

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

B. ASTM D-1784: Rigid Poly (Vinyl Chloride) Compounds And Chlorinated Poly (Vinyl Chloride) Compounds

C. ASTM D-1785: Poly (Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, 120

D. ASTM D-2241: Poly (Vinyl Chloride) Pressure-Rated Pipe (SDR Series)

E.	ASTM D-2321	Recommended Practice For Underground Installation Of Flexible Thermoplastic Sewer Pipe
F.	ASTM D-2464	Threaded Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80
G.	ASTM D-2466	Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40
H.	ASTM D-2467	Socket-type Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80
I.	ASTM D-2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
J.	ASTM D-2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
K.	ASTM D-2729:	Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
L.	ASTM D-2837:	Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials.
M.	ASTM D-3034:	Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
N.	ASTM D-3139:	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
O.	ASTM D-3212:	Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals.
P.	ASTM F-477:	Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
Q.	ASTM F-679:	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
R.	ASTM F-894:	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
S.	ASTM F-1417:	Standard Test Method for Installation Acceptance of Plastic Sewer Lines Using Low-Pressure Air.

T. ANSI/AWWA C104/A21.4: Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.

U. ANSI/AWWA C110/A21.10: Ductile-Iron and Gray-Iron Fittings 3 In. Through 48 In.

V. ANSI/AWWA C111/A21.11: Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

W. ANSI/AWWA C115/A21.15: Flanged Ductile Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.

X. ANSI/AWWA C150/A21.50: Thickness Design of Ductile Iron Pipe.

Y. ANSI/AWWA C151/A21.51: Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

Z. ANSI/AWWA C153/A21.53: Ductile Iron Compact Fittings 3 In. Through 24 In. and 54 In. Through 64 In. For Water Service.

AA. ANSI/AWWA C105/A21.5: Polyethylene Encasement for Ductile Iron Pipe Systems

BB. AWWA C900: Poly (Vinyl Chloride) (PVC) Pressure Pipe, 4 in. Through 12 in. for Water Distribution

CC. 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

A. Submit under provisions of Section 01300, Submittals.

B. 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.

C. Manufacturer’s Certificates: Contractor shall furnish the following prior to shipment:

1. Affidavit of compliance with applicable standard.

2. Test certificates.

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

1.6 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 01700.

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

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

1.7 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.

1.8 FIELD MEASUREMENTS

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

1.9 COORDINATION

A. Coordinate sanitary sewer and wastewater pressure piping construction with other work.

2PART 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. PVC SDR-21-PR pipe shall be used for forcemain piping.

1. PVC SDR-35 shall be used for gravity sewer main piping.

2. PVC SDR-26 shall be used for gravity sewer service piping.

3. Ductile iron pipe shall be used for valve vault, piping in the lift station shall be Sch. 80 PVC.

B. Type PSM Polyvinyl Chloride 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. Restrained Joint PVC: Pipe shall be joined using non-metallic couplings to form an integral system for maximum reliability and interchangeability. High-strength, flexible thermoplastic splines shall be inserted into mating, precision matched grooves in the pipe and coupling to provide full 360° restraint with evenly distributed loading.

Couplings shall be designed for use at or above the rated

pressures of the pipe with which they are utilized, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the leakage test requirements of ASTM D3139.

5. 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.

   a) Fittings defined as tee or wye connections suitable for assembly to 4-inch or 6-inch sewer service laterals shall be bell-end and shall be furnished by the pipe manufacturer.

C. Polyvinyl Chloride Plastic Pressure Pipe and Fittings (SDR-PR PVC): Shall meet the requirements of ASTM D-1784 cell classification 12454-B for PVC compounds, and ASTM D-2241 for poly vinyl chloride (PVC) pressure pipe.

1. The resin portion of the copolymer compounds shall contain a minimum of 70 percent vinyl chloride and the compounding ingredients shall not exceed 30 percent by weight. The compounding ingredients may consist of lubricants, stabilizers, non poly (vinyl chloride) resin modifiers, and pigment essential for processing, property control, and coloring.

2. Minimum wall thickness shall conform to Standard Dimension Ratio 21 (SDR 21).

3. The Contractor shall install the maximum pipe lengths manufactured by the supplier.

4. Joints: Joints shall be push-on type with integral bell and spigot and elastomeric gaskets meeting the requirements of ASTM D-3139. Rubber gasket rings shall be neoprene or other synthetic material and conform to ASTM F-477. Natural rubber gaskets will not be acceptable.

5. Fittings: Shall meet the requirements of ASTM D-1784 cell classification 12454-B for PVC compounds. Fitting joints shall be bell and spigot with elastomeric gaskets, meeting the requirements of ASTM D-3139. Where specifically indicated on the drawings or

directed by the Engineer, socket type Schedule 80 fittings in conforming with ASTM D-2467, with solvent cemented joints in conformance with ASTM D-2855, shall be used.

D. 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 Special Thickness Class 53.

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 flanged joints. Joints for buried piping shall be restrained mechanical joint for sections of pressure conduits requiring joint restraint, as specified in Part 3 of this Section. Joints for concrete encased piping and buried piping not requiring joint restraint shall be either mechanical joint or push-on joint.

3. Joint Requirements:

a) 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" thick, conforming to Appendix B of ANSI/AWWA C111/A21.11.

b) Push-on Joints: Shall conform to ANSI/AWWA C111/A21.11. Push-on joint gaskets shall be neoprene or synthetic rubber.

c) Mechanical Joints: Shall conform to ANSI/AWWA C111/A21.11. Mechanical joint gaskets shall be neoprene or synthetic rubber.

d) 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. Restraining wedges shall be one

piece, circular shaped, that has continuous contact with the pipe.

4. Fittings: 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. shall be used in ductile iron piping only where specifically indicated on the Drawings or approved by the Engineer.

5. Lining: All pipe and fittings shall be provided with cement-mortar lining conforming to ANSI/AWWA C104/A21.4, or a 30 mil polyethylene lining in accordance with ASTM D -1248.

6. 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.

7. Shop primer: Exterior surfaces of all pipe and fittings to be located completely or partially inside wetwells or vaults, or in exposed locations, 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.

8. Polyethylene Tube: Shall be seamless, ANSI/AWWA C105/A21.5.

2.2 PIPE ACCESSORIES

A. Banded Couplings: Banded couplings for gravity sewer piping shall be synthetic rubber repair couplings with stainless steel clamping ring bands. Banded couplings shall be provided to transition between different materials and sizes as required.

B. Connection saddles: Connection saddles for connection of sewer laterals and service connections to PVC sewer pipe shall be rigid, banded, saddle type fittings of PVC plastic with a neoprene or synthetic rubber gasket.

C. 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.

D. 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. Gasket material 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", or Smith-Blair “441 or 411” or approved equal.

E. Flanged Coupling 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.

F. Wall Castings: Wall castings 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.

G. Tracer Wire: Tracer wire shall be #12 THHN copper location wire.

H. 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 02220, Earthwork and Trenching.

2.4 BACKFILL MATERIALS

A. Backfill materials shall be as specified in Section 02220, Earthwork and Trenching.

2.5 STEEL CASING

A. Steel Casing: Steel casings for bored, jacked or open trench construction shall be steel pipe conforming to ASTM A 139 with a minimum diameter as shown on the Drawings.

1. Minimum wall thickness shall be in accordance with the following table:

Diameter of Casing-Inches	Nominal Wall Thickness-Inches Under Railroads	All other Uses
8-16	0.250	0.188
18	0.312	0.250
20	0.375	0.250

2. Steel shall be Grade B under railroads and Grade A on all other uses.

3. Steel pipe shall have welded joints in accordance with AWWA C 206

B. Casing spacers: Casing spacers shall be used with all casing. Casing spacers shall have a minimum of 4 runners and shall hold the carrier pipe in the center of the casing. Casing spacers shall have lined stainless steel sleeve and UHMW plastic runners.

C. Casing end seals: Ends shall be sealed with synthetic rubber, wrap-around end seals with stainless steel bands.

3PART 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. The Contractor may utilize the toll free number for the "Missouri One Call System, Inc." 1-(800) Dig-Rite. 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.

3.3 PROTECTION

A. Locate and identify utilities that remain and protect them 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. See Section 01010 – Summary of Work
2.0 Separation of Water and Sewer Utilities

3.5 SERVICE LINES AND CONNECTIONS

A. There shall be one service connection made for each structure shown on the plans. A service connection shall consist of connecting to the existing pipe, within 5 feet of the outer wall, with a clean-out and constructing new line to the sewer main and connecting with a tee or wye fitting. Additional clean-outs shall be placed at changes in alignment of 45 degrees or greater and at a maximum of 150 foot intervals.

B. Lagoon shall be approved and accepted by MO DNR before service connections are made to existing house lines.

3.6 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 02220 - Earthwork and Trenching.

3.7 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. A double sling shall be required when handling plastic pipe 10 feet or longer.

B. Install pipe of the size, material, strength class, and joint type as specified or indicated on the drawings.

C. 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.

D. 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 three inches. Joint deflection shall not exceed the maximum allowable deflection per joint according to ASTM C-425 for clay pipe, D-3034 and F-679 for plastic gravity sewer pipe, F-714 for polyethylene pipe, ANSI/AWWA C600 for ductile iron pipe. 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.

E. 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.

F. 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.

G. 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.

H. 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 02220 - Earthwork and Trenching.

I. 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.

1. Check joint position and condition after assembly prior to installing additional pipe sections.

2. Check joint opening and deflection for specification limits.

J. 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 sharp edges.

K. Point Repairs and Connection to Existing Pipe: Where point repairs in existing sewer lines are required, the following shall apply:

1. Replacement length shown on the drawings is approximate and measured to the nearest pipe joint. Actual replacement shall

proceed to the nearest sound pipe joint as approved by the Engineer or the Owner's representative.

2. Replacement length shown on the drawings plus 3 feet on either end shall be considered incidental to the Work at the location.

3. Pipe connections to existing pipe shall be made with banded couplings as specified herein.

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

1. Pipes shall be connected to new structures using flexible entrance seals.

2. Pipe connection to existing structures shall be made with two inches clearance surrounding the pipe or fitting. PVC pipe shall be fitted with a grouting ring. The opening between the pipe and structure shall be filled with patching material to form a water tight seal.

3. Gravity sewer 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 patching material, as specified in Section 02738.

M. Tracer wire shall be installed so that it will lay adjacent to and below the centerline of, all new forcemains. Wire shall extend up and connect to markers as directed by Engineer. Markers shall be reboundable plastic, of such blend to keep it from becoming brittle in cold weather or softening in hot weather. They shall be green in color with white lettering stating "sewer" and constructed of materials that shall resist fading in sunlight. Markers shall be of a triangular section to allow the text to be read from any direction. They shall be at least 60" in length and shall have external terminals for tracer wire. Markers shall be placed near fences where applicable.

3.8 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 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.

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. Push-on Joints: Push-on joints shall be assembled according to the manufacturer's recommendations. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

F. 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.

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

3.9 STEEL-CASINGS FOR BORED OR JACKED CROSSINGS

A. Installation of steel casing shall be performed by a person experienced in such work. Casing shall be installed by a combination of augering & jacking. Alignment and gradient shall be such that the carrier conduit can be installed to the line and grade shown on the Drawings.

B. Welding shall be performed by a person experienced with the type of welding necessary. All welds shall conform to AWWA C 206.

C. After completion of the installation of the casing, the carrier conduit shall be carefully pushed or pulled through the casing in a manner that will maintain proper jointing of the pipe joints and provide the required gradient and alignment. Casing spacers shall be provided.

D. Casing spacers: Casing spacers shall be installed per approved manufacturer's printed recommendations, or a 6 foot spacing, whichever provided greater support. Casing spacers are required at each end of casing. Spacers shall have runners attached to the shell and be designed to provide a minimum of 0.75 inches clearance between the carrier pipe's greatest outside diameter and the casing pipe's inside diameter.

E. Air testing: Casing pipes shall be air pressure tested APWA Standard Specifications Section 2509.4.2.c, prior to the placing of the end seals.

4.0 JOINT RESTRAINT FOR PRESSURE PIPING: Joint restraint shall be provided for portions of piping which will serve in a pressure flow application, including: force mains, pressure sewers, and process piping.

A. Joint restraint for SDR-PR PVC pressure pipe shall be accomplished by means of thrust blocks, as shown and detailed on the drawings or by the use of bell restraint clamps for joints between pipes, and fitting restraint devices at joints with fittings, where shown on the drawings and as specified herein. Joints shall be restrained for minimum distance from fittings as given in the table below.

LENGTH (ft) OF RESTRAINED JOINT REQUIRED: SDR-21 PVC PIPE

Pipe Size	90° Bend Horizontal	45° Bend Horizontal	45° Bend Vertical	22° Bend	Tee Branch[1] (equal size)	Reducer (one size)
2"	10	5	10	5	5	10
3"	10	5	10	5	5	10
4"	10	5	10	5	5	10
6"	15	10	10	5	5	10
8"	20	10	15	5	5	15
10"	25	10	15	10	5	15
12"	25	15	20	10	10	20

[1] In the straight-through direction, the minimum length of the first pipe on either side of the tee shall be 10 feet.

B. Joint restraint for ductile iron piping shall be accomplished using mechanical joints with restraining glands. Joints shall be restrained for minimum distance from fittings as given in the table below.

LENGTH (ft) OF RESTRAINED JOINT REQUIRED: DUCTILE PIPE (with polyethylene wrap)

Pipe Size	90° Bend Horizontal	45° Bend Horizontal	45° Bend Vertical	22° Bend	Tee Branch[1] (equal size)	Reducer (one size)
4"	10	5	10	5	5	20
6"	15	5	15	10	10	20
8"	20	10	20	10	15	20
10"	25	10	25	15	25	20
12"	25	15	30	15	35	20
14"	30	15	30	15	40	20

16"	35	15	35	20	50	25

[1] In the straight-through direction, the minimum length of the first pipe on either side of the tee shall be 10 feet.

4.1 GRAVITY SEWER ACCEPTANCE TESTING:

A. All new sewer segments between manholes or structures will be subject to acceptance testing under this subpart. Partial sewer main segment replacements and point repairs will not be tested under this subpart.

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: “Standard Test Method for Installation Acceptance of Plastic Sewer Lines Using Low-Pressure Air”. The air equipment shall consist of necessary valves and pressure gauges to control and 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.

3. 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.

4. Test each reach of pipe between manholes after completion of pipe and appurtenance installation and trench backfill.

5. 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.

6. 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.

7. 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.
6"	7:34	7:34	7:34	7:36	8:52	10:08	11:24
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

8. 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.

9. In areas where ground water is known to exist, a ½-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.

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.

E. Compensation for Testing:

1. All testing of pipe and manholes shall be performed by the Contractor at the Contractor’s expense.

4.2 PRESSURE PIPING ACCEPTANCE TESTING

A. All new sewer force mains, pressure sewers, and pressure process 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. 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.

C. Test Conditions:

1. Test pressure shall be 50 psi (gauge). 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 $\pm$5 psi for the duration of the test.

D. Test materials: Contractor shall supply all of the necessary plugs, hose, riser pipe, pumps, gauges, water and other equipment as required for the testing.

E. 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 if 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.

F. 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.

G. 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.

4.3 FIELD QUALITY CONTROL

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

B. Compaction and soil testing will be performed in accordance with Section 02220.

END OF SECTION

SECTION 02738

MANHOLES AND COVERS

1PART GENERAL

1.1 The Contractor shall furnish and install all manholes/wetwells, 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. New sanitary sewer manholes/wetwells and appurtenances

B. Manhole wall reconstruction.

C. Pipe connections to manholes/wetwells.

D. Manhole testing.

1.3 RELATED SECTIONS

A. Section 02220 - Earthwork and Trenching

B. Section 02730 - Sewage Piping Systems

1.4 REFERENCES

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

B. ASTM A-48 Gray Iron Castings

C. ASTM A-615 Deformed And Plain Billet-Steel Bars For Concrete Reinforcement

D. ASTM C-32 Sewer And Manhole Brick (Made From Clay Or Shale)

E. ASTM C-139 Concrete Masonry Units For Construction Of Catch Basins And Manholes

F. ASTM C-270 Mortar For Unit Masonry

G. ASTM C-478 Precast Reinforced Concrete Manhole Sections

H. ASTM C-923 Specification For Resilient Connectors Between Reinforced Concrete Manhole Structures And Pipes

1.5 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals.

B. Product Data for Review:

1. Manholes/wetwells, castings, manhole appurtenances.

2. Manhole repair products.

3. Repair mortar.

4. Calculation for structural design of manholes/wetwells.

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

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

1.6 FIELD MEASUREMENTS

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

2PART PRODUCTS

2.1 AGGREGATE AND BACKFILL MATERIALS

A. Crushed rock: Crushed rock material used as a foundation and for leveling of manholes/wetwells, shall be as specified in Section 02220 - Earthwork and Trenching. Granular pipe embedment material may also be used.

B. Backfill materials shall be as specified in Section 02220 - Earthwork and Trenching.

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

A. Precast manholes/wetwells: New manholes 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 4000 psi with Type II cement. Concrete poured on site shall be 3,000 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/wetwells with developed base: The precast concrete manhole shall conform to ASTM C-478. All concrete shall be 4000 psi with 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. 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.

B. Adjusting rings: Adjusting rings shall be precast concrete, with circumferential reinforcement per ASTM C-478.

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 Clay and Bailey Model No. 2007, Deeter Model 1320, Neenah Model 1536 or approved equal with "Sewer" cast on the lid. Castings for shallow manholes shall be Clay and Bailey Model No. 2002, Deeter Model 1332, Neenah Model 1538 or approved equal with “Sewer” cast on lid. Castings for “bolt-down lid” manholes and lids shall be Clay and Bailey Model No. 2014LT, Deeter Model 1313, Neenah 1916-F or approved equal.

E. Protective coating: The protective coating for the interior and exterior of manholes shall be a coal tar system with 64% solids, $\pm$ 2%.

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. The sealant shall contain no asbestos fibers and meet ASTM C-990 standards.

G. Clay brick: 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 meet ASTM C-1107, Grade A standards.

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. Repair mortar shall meet ASTM C-109-92 standards.

2.3 MANHOLE 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.

B. Flexible entrance seals: Cast-in-place flexible entrance seals shall be made of materials meeting the properties in ASTM C-923. The connector shall meet or exceed the performance requirements in ASTM C-923.

3PART EXECUTION

3.1 NOT USED

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

A. Manholes/wetwells shall be designed for the depth shown on the plans. The wall thickness and reinforcing shall be increased, if necessary, to handle the loads. All manholes/wetwells shall be designed to the most recent ACI 318 code.

B. 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. Damaged sections shall be replaced with new sections, except when repairs are permitted by the Engineer.

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

D. Manhole/wetwell construction:

1. Precast concrete manholes/wetwells 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/wetwells 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.

E. 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 no 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.

F. Flexible entrance seals: Where cast-in-place flexible entrance seals are used to seal pipe connections to new manholes/wetwells, 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.

G. Frames and covers: Unless shown otherwise on the Drawings, all castings shall be set flush with finish grade in all roadways, 2 inches above grade in 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. Exterior faces of masonry shall be plastered at least 1/2" thick with mortar.

3.4 PIPE CONNECTIONS TO MANHOLES/WETWELLS:

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

B. Pipe connection to new manholes/wetwells 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/wetwells 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 all rehabilitated manholes shall pass a vacuum leakage test.

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 after assembly and prior to backfilling. All lifting holes shall be plugged with patching material. 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 with patching material, as specified in Section 02762, while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained. If the joint mastic or gasket is displaced during vacuum testing, the manhole shall be disassembled, the seal replaced and the manhole restored.

3.6 FIELD QUALITY CONTROL

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

3.7 PAYMENT

A. Standard manhole is defined as a 48" I.D. manhole of depth 8'. Depth greater than 8' shall be paid for by foot for extra depth. Outside drop

manholes are a separate bid items. No extra payment is allowed for outside drop manholes greater than 8' depth. Manholes of larger I.D. are to be paid for by separate bid item. No extra payment is given for extra depth manhole of I.D. greater than 48".

B. Although payment is allowed for standard manholes of depth greater than 8', no extra payment will be allowed for greater depths caused by manholes and corresponding sewer mains installed to elevations and slopes other than what is shown on the drawings due to installation errors.

END OF SECTION

SECTION 02920

LAWNS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Providing all plant, labor, equipment, and materials and performing all operations necessary for final grading, fertilizing, seeding, liming, and mulching the areas as specified herein.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, signed by product manufacturer.

D. Qualification Data: For landscape Installer.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods. **(NOT APPLICABLE)**

F. Records of all inspections. **(NOT APPLICABLE)**

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress. **(NOT APPLICABLE)**

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

1.7 SCHEDULING

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: March 15 – May 15 .
2. Fall Planting: August 15 – September 30.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 AREAS TO BE TREATED

A. Turf shall be established on all disturbed areas outside the building and paving or per site seeding plan.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 85 percent germination, not less than 98 percent pure seed, and not more than 0.8 percent weed seed:

1. Turf Type Fescue.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 85 percent calcium carbonate equivalent and as follows:
1. Class: Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

2.3 FERTILIZER

A. Fertilizer shall be uniform in composition and free flowing. Fertilizer shall be 12-12-12.

1. Application Rate: 500 pounds per acre.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, threshed straw of wheat, oats, or barley.
1. Application Rate: 2 tons per acre.

2.5 SOIL STABILIZER

A. Stabilize the mulch with a synthetic emulsion similar to HYDRO STOCK 8500. Apply stabilizer uniformly in accordance with the manufacturer's recommendations. In lieu of emulsions, it is acceptable to embed or anchor the mulch into the soil by using an approved disc type roller having flat serrated discs spaced not more than 10 inches apart and equipped with cleaning scrapers.

2.6 WATER

A. Water shall be free from oil, acid, alkali, salt, etc., and shall be from an approved source prior to use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

B. Provide and maintain existing erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways. **(NOT APPLICABLE)**

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Prior to fertilizing, liming, and seeding operations and after final grading, the areas to be seeded shall be harrowed or raked to provide a smooth seed bed.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at the rate of 8 to 10 pounds / 1,000 square feet.

C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly. Watering with fine spray is optional.

3.5 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: Acceptance of seeded areas will be based upon having a dense, well-rooted turf, capable of preventing all erosion. Grass areas which show signs of erosion, ruts, etc., will not be acceptable. Seeded areas shall be mowed to a height of three inches immediately prior to inspection re-establish lawns that do not comply with requirements until lawns are satisfactory.

3.6 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established. **(NOT APPLICABLE)**

C. Remove erosion-control measures after grass establishment period. **(NOT APPLICABLE)**

END OF SECTION

SECTION 03100

CONCRETE FORM WORK

1PART GENERAL

1.1 SECTION INCLUDES

A. Form work for cast-in place concrete, with shoring, bracing and anchorage.

B. Openings for other work.

C. Form accessories.

D. Form stripping.

1.2 RELATED SECTIONS

A. Section 03200 - Concrete Reinforcement.

B. Section 03300 - Cast-in-Place Concrete.

1.3 REFERENCES

A. ACI 301 - Specifications for Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements for Reinforced Concrete.

C. ACI 347 - Recommended Practice For Concrete Form Work.

D. ACI 350 - Environmental Engineering Concrete Structures.

1.4 DESIGN REQUIREMENTS

A. Construct form work, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

1.5 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Product Data: Provide data on void form materials, installation requirements and form ties.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347, 301, 318, and 350.

A. Maintain one copy of each document on site.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable ACI 301 code for design, fabrication, erection and removal of form work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Material and Equipment: Transport, handle, store, and protect products.

B. Deliver void forms and installation instructions in manufacturer's packaging.

C. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.9 COORDINATION

A. Section 01039 - Coordination and Meetings: Procedures for coordination of work.

B. Coordinate this Section with other Sections of work which require attachment of components to form work.

C. If form work is placed after reinforcement resulting in insufficient concrete cover over reinforcement, request instructions from Engineer before proceeding.

2PART PRODUCTS

2.1 WOOD FORM MATERIALS

A. Form Materials: Exterior grade plywood at least 5/8 inch thick, smooth where exposed to view after construction.

3.2 PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

B. Preformed Plastic Forms: Thermoplastic form liner, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

3.3 FORM WORK ACCESSORIES

A. Form Ties: Removable type, galvanized metal or plastic, fixed or adjustable length, cone type, with waterproofing washer, 1-1/2 inch, back break dimension, free of defects that could leave holes larger than 1-1/4 inch in concrete surface.

B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

C. Corners: Chamfer, rigid plastic or wood strip type; 3/4 x 3/4 inch size; maximum possible lengths.

D. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain form work in place while placing concrete.

4PART EXECUTION

4.2 EXAMINATION

A. Verify lines, levels and centers before proceeding with form work. Ensure that dimensions agree with Drawings.

4.3 EARTH FORMS

A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

4.3 ERECTION - Form work

A. Erect form work, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of form work. Shore or strengthen form work subject to overstressing by construction loads.

C. Arrange and assemble form work to permit dismantling and stripping. Do not damage concrete during stripping.

D. Align joints and make watertight. Keep form joints to a minimum.

A. Obtain approval before framing openings in structural members which are not indicated on Drawings.

B. Provide chamfer strips on external corners of beams and walls.

C. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.

4.4 APPLICATION - FORM RELEASE AGENT

A. Apply form release agent on form work in accordance with manufacturer's recommendations.

B. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are effected by agent. Soak inside surfaces of untreated forms with clean water. Keep coated surfaces protected prior to placement of concrete.

4.5 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for items to be embedded or passing through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Ensure items are not disturbed during concrete placement.

E. Provide temporary ports or openings in form work where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

4.6 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless form work and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

4.7 FORM WORK TOLERANCES

A. Construct form work to maintain tolerances required by ACI 301.

B. Camber slabs and beams 1/4 inch per 10 feet (2 mm/m), in accordance with ACI 301.

4.8 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control: Field inspection and testing.

B. Inspect erected form work, shoring, and bracing to ensure that work is in accordance with form work design, and that supports, fastenings, wedges, ties, and items are secure.

C. Do not reuse wood form work more than 2 times for concrete surfaces to be exposed to view. Do not patch form work.

D. Do not use manufactured adjustable shores if wear, damage or defects make them incapable of supporting the loads for which they are designed.

4.9 FORM REMOVAL

A. Beam and wall forms may be removed as soon as the concrete is strong enough to sustain its own weight, but no sooner than 24 hours after placement. Do not remove supporting forms and shoring for level slabs, sloping slabs, beams, and other flexural members until they can support their weight and superimposed loads, and if test cylinders show a strength of 3,000 psi or more in compression, but not sooner than 14 days. Cure test cylinders under conditions similar to those affecting the structure involved.

B. Distribution structures and some floor slabs are supported by walls and beams cast later. Do not remove forms and shoring under those slabs until 14 days after the

walls and beams have been cast.

C. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

D. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

E. Store removed forms in such a manner so that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

1PART GENERAL

1.1 SECTION INCLUDES

A. Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

1.2 RELATED SECTIONS

A. Section 03100 - Concrete Form Work.

B. Section 03300 - Cast-in-Place Concrete.

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 318 - Building Code Requirements For Reinforced Concrete.

C. ACI 350 - Environmental Engineering Concrete Structures.

D. ACI SP-66 - American Concrete Institute - Detailing Manual.

E. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.

F. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

G. ASTM A704/A704M - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.

H. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.

I. ASTM A775/A775M - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

J. ASTM D3963/D3963M - Standard Specification for Epoxy-Coated Reinforcing Steel.

K. AWS - American Welding Society.

L. CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.

M. CRSI 63 - Recommended Practice For Placing Reinforcing Bars.

N. CRSI 65 - Recommended Practice For Placing Bar Supports, Specifications and Nomenclature.

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Shop Drawings: Indicate bar sizes, spacings, locations, quantities of reinforcing steel, bending and cutting schedules, and supporting and spacing devices.

1.5 SUBMITTALS FOR INFORMATION

A. Section 01300 - Submittals: Procedures for submittals.

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

C. Submit certified copies of mill test report of reinforcement analysis.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with CRSI Manual of Practice, Chapter 5 of ACI 301, ACI SP-66, and Chapters 7 and 12 of ACI 318.

B. Maintain one copy of each document on site.

1.7 COORDINATION

A. Coordinate with placement of Form Work, formed openings and other Work.

2PART PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade; deformed billet steel bars, unfinished.

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions, including load-bearing pad on bottom. Clay bricks are not allowed.

C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type; size and shape as required.

2.3 FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI Manual of Practice and ACI 318. Heating of reinforcing steel for bending is not allowed.

B. Welding reinforcement will not be allowed.

3PART EXECUTION

3.1 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position.

B. Position wall dowels projecting from foundations, with templates or guides held in place above the concrete placement line. Position the templates to obtain the required clearance between the dowels and the face of the walls.

C. Accommodate placement of formed openings.

D. Stagger bar splices. Minimum splice length = 40 bar diameters, unless otherwise shown on the drawings.

E. Provide additional reinforcing bars to support top reinforcement in slabs. Do not shift reinforcing bars from positions in upper layers to positions in lower layers as a substitute for additional support bars.

F. Provide additional reinforcing bars to support ties and stirrups in beams where top reinforcement is not continuous.

G. Unless otherwise shown on the Drawings, do not bend reinforcing bars which project from in-place concrete.

H. Maintain concrete cover around reinforcing as follows:

Item	Coverage
Slabs and Joists:	
Top and Bottom Bars for Dry Conditions:	
#14 and #18 bars	1-1/2 in. (38 mm)
#11 and smaller bars	1 in. (25 mm)
Formed concrete surfaces exposed to earth, water or weather, and over or in contact with sewage and for bottoms bearing on work mat, or slabs supporting earth cover:	
All bars	2 in. (50 mm)
Beams and Columns:	
For dry Conditions:	
Stirrups, spirals and ties	1-1/2 in. (38 mm)
Principal reinforcement	2 in. (50 mm)
Exposed to earth, water, sewage, or weather:	
Stirrups and ties	2 in. (50 mm)
Principal reinforcement	2 1/2 in. (64 mm)
Walls:	
For Dry Condition:	
#11 and smaller bars	1 in. (25 mm)
#14 and #18 bars	1-1/2 in. (38 mm)
Formed concrete surfaces exposed to earth, water, sewage, weather, or in contact with ground:	
Circular tanks with ring tension	2 in. (50 mm)
All others	2 in. (50 mm)
Walls 12 in. or over in thickness with pours more than 10 ft	2 1/2 in. (63 mm)
Floorings and Base Slabs:	
At formed surfaces and bottoms bearing on concrete work mat	2 in. (50 mm)
At unformed surfaces and bottoms in contact with earth	3 in. (76 mm)
Top of footings - same as slabs	
Over top of piles	2 in. (50 mm)

A. Electrical grounding of reinforcement - Not Used

3.2 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control: Field inspection.

3.3 SCHEDULES

A. Reinforcement For All Structures: Deformed bars, unfinished.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

1PART GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete floors, slabs, suspended slabs, walls, foundation walls.

B. Control, expansion and contraction joint devices associated with concrete work, including joint sealants.

C. Equipment pads, light pole base, thrust blocks, manholes, and vaults.

1.2 RELATED SECTIONS

A. Section 03100 - Concrete Form Work.

B. Section 03200 - Concrete Reinforcement.

1.3 REFERENCES

A. ACI 301 - Structural Concrete for Buildings.

B. ACI 302 - Guide for Concrete Floor and Slab Construction.

C. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

D. ACI 305R - Hot Weather Concreting.

E. ACI 306R - Cold Weather Concreting.

F. ACI 308 - Standard Practice for Curing Concrete.

G. ACI 318 - Building Code Requirements for Reinforced Concrete.

H. ACI 350R - Environmental Engineering Concrete Structures.

I. ASTM C33 - Standard Specification for Concrete Aggregates.

J. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

K. ASTM C150 - Standard Specification for Portland Cement.

L. ASTM C231 - Standard Test Method for Air Content of Freshly-mixed Concrete by the Pressure Method.

M. ASTM C260 - Standard Specification for Air Entraining Admixtures for Concrete.

N. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

O. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

P. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

Q. ASTM D1190 - Standard Specification for Concrete Joint Sealer, Hot-Poured Elastic Type.

R. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

S. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Product Data: Provide data on joint devices, joint sealants, attachment accessories, and admixtures.

1.5 SUBMITTALS FOR PROJECT CLOSEOUT

A. Section 01700 - Contract Closeout: Submittals for contract closeout.

B. Project Record Documents: Accurately record actual locations of embedded utilities and components which are concealed from view.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Maintain one copy of each document on site.

C. Acquire cement and aggregate from same source for all work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306R when concreting during cold weather.

1.7 COORDINATION

A. Section 01039 - Coordination and Meetings: Provisions for the coordination of the work.

B. Coordinate the placement of joint devices with erection of concrete form work, placement of form accessories, and equipment supplier's requirements.

2PART PRODUCTS

2.1 CONCRETE MATERIALS

A. Cementitious Materials

1. For pavements, walkways and architectural concrete work, general purpose buildings, Portland Cement ASTM C150, Type I.

2. For concrete tanks, reservoirs and other structures used in water containment, industrial and domestic water and waste water treatments works, Portland Cement ASTM C150, Type II.

3. Portland Cement ASTM C150, Type III, high early strength, only where directed.

B. Fine and Coarse Aggregates: ASTM C33.

C. Water: Clean and not detrimental to concrete.

2.2 ADMIXTURES

A. Only chloride free admixtures are acceptable. The manufacturer to list the chloride content of the admixture. Make sure admixtures selected are compatible and not harmful to the concrete mix.

B. Air Entrainment: ASTM C260.

1. MB-VR manufactured by Master Builders, Inc. Cleveland, OH.

2. DAREX II-AEA manufactured by W.R. Grace & Co., Cambridge, MA.

3. SIKA AER manufactured by Sika Corporation, Lyndhurst, NJ.

4. Substitution: Under provisions of Section 01600.

C. Chemical: ASTM C494, Type A - Water Reducing, Type D - Water Reducing and Retarding. Other admixtures shall be used only with Engineer's written concurrence.

1. Products manufactured by W.R. Grace & Co. Cambridge, MA.

2. Products manufactured by Euclid Chemical Co. Cleveland, OH.

3. Products manufactured by Gifford-Hill & Co., Charlotte, NC.

4. Substitution: Under provisions of Section 01600.

2.3 ACCESSORIES

A. Bonding Agent: Two component modified epoxy resin.

1. EUCO #352 manufactured by Euclid Chemicals, Co., Cleveland, OH.

2. Sikadur-32 Hi-Mod manufactured by Sika Corporation, Lyndhurst, NJ.

3. Section 01600 - Materials and Equipment: Product options and substitutions.

B. Non-Shrink Grout: Section 3600 - Grout

2.4 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler Type A: ASTM D1751; Asphalt impregnated fiberboard or felt, 1/4 inch thick; tongue and groove profile;

B. Joint Filler Type B: ASTM D1752, Type III; Premolded self-expanding cork, fully compressible with recovery rate of minimum 95 percent;

C. Sealant and Primer: Two-part polysulfide-base elastomeric sealant for water immersed joints.

1. Sonolastic two-part, Grade NS, manufactured by Sonneborn Building Products, Minneapolis, MN.
2. Hornflex-L two-part, Grade NS manufactured by A.C. Horn, Inc. Beltsville, MD.

3. Sikaflex two component, Grade NS manufactured by Sika Corporation, Lyndhurst, NJ.

4. Eucolastic II two-part, Grade NS manufactured by Euclid Chemical Co., Cleveland OH.

5. Substitution: Under provisions of Section 01600.

2.5 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301.

C. Provide concrete which has minimum shrinkage cracks, high durability, high impermeability and maximum resistance to natural or processing chemicals. Provide concrete to meet the following criteria:

Class A: Concrete placed against earth in slabs and footings.

1. Minimum number of bags (pounds) of cement per cubic yard of concrete: 6.00 (564).

2. Maximum water-cement ratio: 0.45.

3. The ratio of sand to total aggregate: 33 to 42 percent by weight based upon surface dry material.

4. Compressive strength (7 days): 3,000 psi (21 Mpa).

5. Compressive strength (28 days): 4,000 psi (28 Mpa).

6. Maximum Slump: 3 inch (76 mm).

Class B Concrete in supported slabs, beams, and walls.

1. Minimum number of bags (pounds) of cement per cubic yard of concrete: 6.00 (564).

2. Maximum water-cement ratio: 0.45.

3. The ratio of sand to total aggregate: 33 to 42 percent by weight based upon surface dry material.

4. Compressive strength (7 days): 3,000 psi (21 Mpa).

5. Compressive strength (28 days): 4,000 psi (28 Mpa).

6. Maximum Slump: 3 inch (176 mm).

Class C: Concrete in fillets, cradles and where used to fill voids or for foundation backfilling and as a mud slab (non-structural applications) covering for subgrade at locations specifically designated on the Drawings.

1. Compressive strength (28 days): 3,000 psi (21 Mpa).

2. Maximum Slump: 4 inch (102 mm).

D. Use accelerating admixtures in cold weather only when approved by the Engineer. Use of admixtures will not relax cold weather placement requirements.

E. Do not use calcium chloride.

F. Use set retarding admixtures during hot weather only when approved by the Engineer.

G. Contractor may use water-reducing, high-range admixture.

H. Add air-entraining admixture to all normal weight concrete mix. Ensure average air content in field mixtures equal to 6 percent plus or minus one percent (6 percent +- 1 percent), in conformance with ASTM C231. For concrete with trowel finished surfaces ensure minimum 3 percent air content.

3PART EXECUTION

3.1 EXAMINATION

A. Section 01039 - Coordination and Meetings: Provisions for coordination and project conditions.

B. Verify requirements for concrete cover for reinforcement.

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into

concrete are accurately placed and positioned securely.

3.2 PREPARATION

A. Compact granular material under concrete before placing concrete.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 304.

B. Notify Engineer a minimum of 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, and embedded parts are not disturbed during concrete placement.

D. Install joint fillers, primer and sealant in accordance with manufacturer's instructions.

E. Separate slabs on grade from vertical surfaces with 1/4 inch thick joint filler, unless otherwise shown on Drawings.

F. Extend joint filler from bottom of slab to within 1/8 inch of finished slab surface.

G. Install construction joint devices in coordination with floor slab placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

H. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

I. Place concrete continuously between predetermined control and construction joints.

J. Do not interrupt successive placement; do not permit cold joints to occur.

K. Saw cut joints within 24 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness, or a minimum depth of 1 inch. Saw cuts shall be arranged so that floor panel lengths are no more than one and a half times the panel width. Maximum panel width is 10 feet.

L. Screed floors and slabs on grade, maintaining surface flatness of maximum 1/4 inch in 10 ft.

M. Take special care to prevent displacement or folding of waterstops. Exert extra effort to embed waterstop fully on both sides, in dense concrete.

N. At the bottom of wall pours and other horizontal construction joints, roughen, clean, and wet concrete surface against which new concrete is to be placed.

3.4 CONCRETE FINISHING

A. Finish concrete wall surfaces in accordance with ACI 301.

1. Smooth Form Finish: Concrete surfaces below grade adjacent to earth and surfaces not exposed to view such as enclosed chambers, vaults, wet wells, inside surfaces of open tanks, reservoirs, and basins.

2. Grout Cleaned Finish: Grout cleaned finish surfaces include, but are not limited to the following:

a. Exposed exterior walls of tanks and structures adjacent to earth to one foot below finished grade.

b. Interior surfaces in basements, tunnels, pipe galleries, equipment rooms and above grade area.

c. Surfaces to be painted, to be protected by coatings or liner.

B. Finish concrete floor surfaces in accordance with ACI 301.

1. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1/8 inch per foot nominal or as indicated on Drawings.

3.5 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Cure concrete floor surfaces in accordance with ACI 308.

D. Spraying: Spray water over floor slab areas and maintain wet for 7 days.

3.6 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section 01400.

B. Provide free access to Work and cooperate with Inspection Personnel.

C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work. Unfavorable results of actual pours may necessitate redesign of mixes.

D. Performance Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

E. Three concrete test cylinders will be taken for every 50 or less cu yds of each class of concrete placed per day.

F. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

G. One slump test will be taken for each set of test cylinders taken.

H. One air content test will be taken for each set of test cylinders taken.

I. Record temperature of concrete sample for each strength test and atmospheric temperature at that time.

3.7 PATCHING

A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

C. Patch imperfections as directed in accordance with ACI 301.

3.8 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Engineer.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

END OF SECTION

SECTION 03600

GROUT

1PART GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-shrinking grout.
2. Epoxy grout.

1.2 SUBMITTALS

A. Submit under provisions of Section 01300, Submittals.

B. Product Data for Review:

1. Grout materials and data sheets.

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

2PART PRODUCTS

2.1 GROUT MATERIALS

A. Non-shrinking Grout: Non-shrinking grout shall be furnished factory premixed so only water is added at jobsite. Non-shrinking grout shall be pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, and shall develop a minimum compression strength of 2400 psi in 48 hours and 7000 psi in 28 days. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

1. Acceptable Products:
   a. “Cormix “Supreme”
   b. L&M “Crystex”
   c. Master Builders “Masterflow 713 Grout” or “Set Grout”
   d. Sauereisen Cements “F-100 Level Fill Grout”
   e. U.S. Grout “Five Star Grout”
   f. UPCO “Upson Super Flow”
   g. Or Equal.

A. Epoxy Grout: Epoxy grout shall consist of a two-component liquid epoxy adhesive of viscosity appropriate to the location and application, and an inert aggregate filler component, when recommended by the adhesive manufacturer. Components shall be packaged separately at the factory and field mixed. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

1. Epoxy Grout for Reinforcing Bent and Threaded Rod Anchors:
   a. For Floors and Horizontal Surfaces:

2. Low Viscosity Moisture insensitive, Master Builders "Concresive 1463", Sika "Hi-Mod LV", or equal.

3. Medium Viscosity Moisture insensitive, Master Builders "Concresive 1001 LPL", Sika "Hi-Mod" or equal.
   a. For Vertical Walls and Overhead Applications: Moisture insensitive, Nonsag consistency; Master Builders "Concresive 1441", Sika "Hi-Mod Gel", or equal.

4. Epoxy Grout for Headed Anchor Bolts:
   a. Adhesive: Moisture insensitive;
   b. Aggregate: As recommended by the epoxy grout manufacturer.

B. Water: Water used to mix products shall be clean and potable. Questionable water shall be tested by a laboratory in accordance per ASTM C-94 procedure. Potable water need not be tested.

3PART EXECUTION

3.1 NONSHRINKING GROUT: Nonshrinking grout shall be used for the grouting of all equipment baseplates or bedplates, column baseplates, other miscellaneous baseplates, wall fittings, and other uses of grout as indicated on the Drawings. Unless otherwise specified, all grouting shall be done with nonshrinking grout.

A. Preparation: The concrete foundation to receive non-shrinking grout shall be saturated with water for 24 hours prior to grouting.

B. Placement: Unless otherwise specified or indicated on the drawings, the thickness of grout under baseplates shall be 1-1/2 inches. Grout shall be placed in strict accordance with the directions of the manufacturer so all spaces and cavities below the top of baseplates and bedplates are completely filled, without voids. Forms shall be provided where structural

components of baseplates will not confine the grout.

C. Edge Finishing: In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.

D. Curing: Non-shrinking grout shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 7 days.

3.2 EPOXY GROUT:

A. Preparation: Where indicated on the drawings, anchor bolts and reinforcing bars shall be epoxy grouted in holes drilled into hardened concrete.

1. Diameter of holes shall be as follows:

a.	Reinforcing Bars and Threaded Rod Anchors	1/8 inch larger than the bar rod outside diameter
b.	Headed Anchor Bolts	Bolt diameter plus 2 inches

2. The embedment depth for epoxy grouted anchor bolts, threaded rod anchors, and reinforcing bars shall be not less than 15 bolt, rod or bar diameter unless indicated otherwise on the drawings.

3. Holes shall be prepared for grouting as recommended by the grout manufacturer.

B. Installation:

1. Anchor bolts, threaded rod anchors, and reinforcing bars shall be clean, dry, and free of grease and other foreign matter at time of installation.

2. The bolts, rods, and bars shall be set and positioned, and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Particular care shall be taken to ensure that all spaces and cavities are filled with epoxy grout, without voids.

3. During assembly of all threaded stainless steel components, anti-seize thread lubricant shall be liberally applied to the threaded portion not embedded in concrete.

END OF SECTION

SECTION 11307

SUBMERSIBLE GRINDER PUMP STATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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 02730 - Sewage Piping System

B. Section 03300 - Cast-In-Place Concrete

C. Division 16000 - Basic Electrical Materials and Methods

D. Section 16900 - Controls and Instrumentation

1.3 REFERENCES

A. Reference Standards: Comply as a minimum with applicable provisions and recommendations of the following:

1. Standards of the Hydraulic Institute.
2. NEC, National Electric Code.
3. NEMA, Standards of National Electric Manufacturers Association.
4. IEEE, Institute of Electrical and Electronic Engineers.
5. AFBMA, Anti-Friction Bearing Manufacturers Association.
6. ANSI, American National Standards Institute.
7. SSPC, Steel Structure Painting Council
8. ASTM, American Society for Testing and Materials.
9. AISI, American Iron and Steel Institute.

1.4 DEFINITIONS

A. NPSH - Net Positive Suction Head.

B. NPSHR - Net Positive Suction Head Required.

1.5 SUBMITTALS

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

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

C. 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.

D. Submit characteristic curves showing the head-capacity relationship, brake horsepower, NPSH requirements, pump efficiency (ratio of the water horsepower to brake horsepower) and pump speed. The curves shall be complete for the entire range of operation from shutoff to minimum head conditions.

E. Submit operation and maintenance data under provisions of Section 01300-Submittals and Section 01700 - Contract Closeout.

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

G. Submit copy of pump warranty.

1.6 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.

1.7 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.

1.8 WARRANTY

A. Provide warranty under provisions of Section 01700 - Contract Closeout.

B. Pump manufacturer shall furnish to the Owner a written warranty against defects in workmanship and materials for two (2) years or 10,000 hours of operation, whichever is less, under normal use and service. All parts shall be covered under warranty, and controls shall be included. Coverage shall be full and not prorated. Pumps shall be picked up by manufacturer's representative or shipping covered under warranty. Pumps shall be repaired under warranty and shall be returned to Owner freight-pre-paid. Warranty shall be in printed form.

C. 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.

D. Responsibilities of Owner: Owner will be responsible for the following activities:

1. Change the oil in the reservoir at manufacturer's recommended interval, but such interval shall not be required by the warranty to be less than 12 months.

2. Maintain the pumping units in good working order, including clearing pump blockages.

3. Allow the pumps to be alternated or exercised regularly to distribute wear and prevent prolonged periods of inactivity.

4. Perform routine troubleshooting and run diagnostics, as outlined in the Operation and Maintenance Instructions.

5. When a problem occurs, perform initial troubleshooting and assessment of situation, eliminating the problem if possible. Contact the manufacturer if expertise or service is required.

6. Owner shall maintain a log of all maintenance performed on the equipment during the warranty period, and shall furnish the manufacturer a copy of this log upon request.

E. Effective Date: The warranty shall become effective upon Substantial Completion of the Work, or the date which the last of the pumps is started, if it occurs 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 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.

2.2 DESIGN REQUIREMENTS:

A. See Pump Schedule, herein, for additional design requirements and motor voltage.

2.3 WETWELL AND VALVE VAULT

A. The wetwells and valve vaults shall be as shown on the Drawings.

2.4 GRINDER PUMP SCHEDULE

Pump Station Name	Rest Area Liftstation
Number of Units	2
Rated Total Head, feet	203
Minimum Capacity (per pump) at Rated Total Head, g.p.m.	50
Minimum Shut-Off Head, feet	221
Operating Head Range, feet	190-208
Max (nominal) Pump Operating Speed at Rated Head, rpm	3450
Motor Power (Volts/Ph/Hz)	230/3/60
Maximum Nameplate HP	10
Discharge Size, inches	2.5

2.5 PUMP CONSTRUCTION

A. Casing:

1. 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 construction. All surfaces, coming into contact with sewage, other than stainless steel or brass, shall be protected by an approved sewage resistant coating. Exposed bolts and nuts made of ASTM A-276, Type 420 or Type 316 are acceptable.

2. 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.

B. Cable Entry:

1. 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.

2. Cable shall be capable of operating under continuous submergence without loss of watertight integrity to a depth of 50 feet.

C. Submersible Motor

1. The pump motor shall be a squirrel-cage, induction, shell type design, housed in an air-filled, watertight chamber. Oil filled motors are not acceptable. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation which will resist a temperature of 155 degrees C (311 degrees 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 degrees 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.

2. 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.

3. Pump motors and all associated wet well equipment shall be FM rated explosion proof for Class I, Division I, Groups C and D.

D. 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.

E. Pump Seal: Each pump shall be provided with a tandem mechanical shaft seal system.

1. 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.

2. 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.

3. 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.

F. 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.

1. 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.

G. 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.

H. Impeller:

1. 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.

2. 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.

3. 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.

    a. 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.

4. 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.

I. Bolts, Studs and Nuts:

1. 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.

2. 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.

3. Steel anchor bolts, flange bolts, studs and nuts shall be Type 316 stainless steel.

2.6 ACCESSORIES FOR WETWELL MOUNTED PUMPS

A. Pump Discharge Connection: Pump discharge connection elbow and discharge piping shall be installed such that pump will automatically connect and seal to discharge connection elbow when lowered into place.

1. Base elbow connected to discharge piping and anchored to sump floor with stainless steel anchor bolts. Pump supplier shall provide 304L or 316 stainless steel threaded rod anchors ¾” minimum diameter, 5" minimum embedment for anchorage of base elbow. Epoxy grout into concrete slab.

2. Note: Base shall consist of elbow integrally cast with mounting base. Base which requires attachment of a separate elbow will not be acceptable. Base shall have holes sized to accept ¾” diameter anchor bolts.

3. Designed to receive pump discharge connection without bolts.

4. Designed to receive guide rail(s).

5. Cast or ductile iron.

6. Flanges shall conform to ANSI B16.1.

7. Seal interface of the pump and discharge elbow by non-sparking metal-to metal contact, or by metal to rubber contact with the use of a profile gasket mechanically held in place between the pump and the sliding guide bracket.

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

C. Guide Rails:

1. Stainless-steel pipe, Schedule 40 minimum.
2. All 316 or 304L stainless steel, including rails, brackets, and anchor bolts.
3. Size as recommended by pump manufacturer, 1-1/2-inch minimum dia.
4. Shall not support any portion of the pump weight.
5. 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.
6. Provide upper guide rail bracket, cast iron or stainless steel.

D. Power and Control Cable Holder: (Provide for tank or wetwell mounted pumps.)

1. 304L stainless steel, with mounting bracket.
2. Provide grip holders for pump and control cables.
3. Cables shall be easily adjusted to pumping level without splices.
4. Provide power and control cables which are sealed at the motor and continuous from the motor to the panel or intermediate waterproof junction box for removing submersible pump for maintenance.
5. Provide stainless steel Kellems grips for power cords.

E. Aluminum Access Hatches:

1. Acceptable Manufacturers: Access hatches shall be of the size as required by pump manufacturer and shall be manufactured by the following or equal:
   a. Bilco Company
   b. Halliday Products
   c. Pennsylvania Insert Corp.
   d. Approved equal

2. Description:
   a. Access hatches in exterior locations shall be floor door type, designed to withstand a live load of 300 pounds per square foot.
   b. Door leaves shall be 1/4 inch thick aluminum diamond pattern plate.
   c. Frame: Angle Frame.
   d. 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.

e. Finish: Hatches shall be mill finished. All surfaces of aluminum which will be in contact with concrete or mortar when installed shall be given a heavy coat of coal tar or bituminous paint.

F. Other Accessories: Provide other accessories indicated on the Drawings.

2.7 PIPING AND VALVES

A. Pump Discharge Piping In Wetwell: As indicated on the Drawings.

B. PVC Ball Valves: PVC ball valves shall be provided where indicated on the Drawings.

1. PVC ball valves shall be full-size port, true-union design with two-way blocking capability, rated for 150 psi at 70℉. Valves shall have PVC bodies, Viton or EPDM O-rings, and Teflon seats. Valves shall be provided with operating levers. Where noted on the Drawings, valves shall be provided with operating nuts, stem extensions with operating handle, and wall supports. The stem extensions and supports shall be a kit supplied by the valve manufacturer and designed to work with the valve used. PVC ball valves shall be Asahi/America “Duo-Bloc”, Hayward “Safe Block”, or equal.

C. Bronze Flapper Check Valves: Bronze flapper check valves shall be provided where indicated on the Drawings.

1. Bronze flapper swing check valves shall be class 125 and shall comply with MSS-SP-80 type 3. Valves shall have bronze bodies, caps, discs and hinges, brass hinge pins and side plugs and stainless steel retaining rings. Ends shall be threaded. Bronze flapper swing check valves shall be as manufactured by Watts, or equal.

2.8 SHOP PAINTING

A. All surfaces, other than stainless steel, coming into contact with the liquid media shall be protected by a shop-applied epoxy paint system, suitable for operation in sewage.

B. Machine finished surfaces:

1. Clean machined parts are to remove all dirt and grease.

2. Clean so as not to affect primer or deteriorate adherence to finish paint.
3. Store and transport in such a way that rust-attach on machined surfaces does not occur.
4. At assembly, coat surfaces with a corrosion preventive coating.

2.8 PUMP PROTECTION SYSTEM: Furnished by pump manufacturer.

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.

2.9 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 overtemperature) 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.

2.10 ELECTRICAL EQUIPMENT AND CONTROLS

A. Conform to NEC, NEMA, IEEE and DIVISION 16 on all electrical equipment and controls.

B. Refer to Section 16900 for electrical control panel, motor starters, and pump controls.

PART 3 EXECUTION

3.1 INSTALLATION: All Work shall conform to the Drawings, the manufacturer's recommendations, and the requirements of Section 16000.

A. Install wetwell cover and access hatch.

B. Attach base elbows, guide rails, and make piping connections.

C. Make all electrical and control connections, in accordance with Section 16000 and Section 16900.

D. Provide a complete unit with all materials, components and adjustments as required for successful operation.

3.2 START-UP AND TESTING:

A. Provide all necessary lubrication for initial start-up, testing and as required for final acceptance.

B. Installation, start-up and testing of all equipment and associated construction shall conform to manufacturer's recommendations.

3.2 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.
   a. Test all control sequences and functions.
   b. Perform complete megger 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

SECTION 11600

HOISTS AND CRANES

PART 1 GENERAL

1.1 GENERAL: Equipment and accessories provided under this section shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with Drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

1.2 SECTION INCLUDES

A. Portable Davit Crane and Accessories

1.3 REFERENCES: Equipment provided under this section shall comply with the applicable requirements of the following. The revision in effect at the time of the bid opening shall be applicable.

A. Occupational Safety and Health Standards of the U. S. Department of Labor; Subpart N, Materials Handling and Storage

B. Monorail Manufacturer's Association (MMA) "Specifications for Underhung Cranes and Monorail Systems".

C. ANSI/ASME HST-2M, "Performance Standard for Hand Chain Manually Operated Chain Hoists".

D. ANSI/ASME B30.10, "Hooks".

E. ANSI/ASME B30.11, "Monorails and Underhung Cranes".

F. ANSI/ASME B30.16, "Overhead Hoists (Underhung)".

G. ANSI MH27.1, "Specifications for Underhung Cranes and Monorail Systems".

1.4 SUBMITTALS: The following items shall be submitted as required by this Division, in accordance with Section 01300 - Submittals, and Section 01700 - Contract Closeout:

A. Product Data for Review: Complete outline and assembly Drawings, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished, shall be submitted for all equipment provided in this Section, in accordance with Section 01300 - Submittals.

B. Operation and Maintenance Data: Approved Operation and Maintenance Instructions shall be provided in accordance with Section 01700 - Contract Closeout.

1.5 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements: Davit crane and hoist will be used to assist in servicing submersible pumps at lift stations. The equipment supplied shall be suitable for use and operation in an exterior location.

B. General Design Requirements: Loading, impact allowances and allowable stresses shall be in accordance with the governing standards.

PART 2 PRODUCTS

2.1 DAVIT CRANE: Provide one davit crane. Install a crane base at each station.

A. Components
1. Winch shall be equipped with bronze bearings for smooth and efficient operation.
2. Wire rope anchor shall be secured to an anchor hole in the flange of the drum, allowing rapid attachment or removal of wire rope from the crane, so that wire rope assemblies can be left permanently attached to submersed pumps and mixers while the crane is moved to a new location.
3. Boom and mast rotate 360 degrees under load, in a bearing sleeve in the base. A pivoting handle shall be provided.
4. Boom shall be adjustable to three different positions for operation, and shall fold down for storage or transport.
5. Loads shall be lifted with a stainless steel spur gear hand winch contained within the boom. The winch shall be equipped with an automatic disc brake for load control, and gear covers to protect gears and help prevent injuries. Winch components shall have zinc and iridescent dichromate plated finish for corrosion resistance.
6. Lifting Capacity: 1,000 pounds.

C. Accessories
1. One (1) pedestal base, or equal.
2. One (1) stainless steel 1/4" diameter wire rope, with stainless eye hook and swagged ball fitting, with minimum length of 28 feet.
3. Galvanized steel expansion anchor bolts for anchoring base, 5/8" minimum diameter.

D. Finishes
1. Crane and bases shall have a galvanized finish for superior corrosion protection.

PART 3 EXECUTION

3.1 INSTALLATION: All work shall conform to manufacturer's recommendations and the requirements of Division 1.

END OF SECTION

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. Distribution system for power at the service entrance install a branch-circuit bolt-on type breakers in the existing meter panel. Power system shall be 240/120 volt (V), 60 Hertz (Hz), 1-phase, 3-wire.
2. Installation of control panel, motor starters and controls, whether provided under this section or other sections of these specifications.
3. Grounding system.
4. Dusk to Dawn light fixture.
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):
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):
04.4 Methods Of Static Tests For Wood Poles
05.1 Specifications And Dimensions For Wood Poles
011.7 Specifications For Pentachlorophenol

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

D. National Fire Protection Association (NFPA):
NFPA 70: National Electrical Code (NEC).
NFPA 78: Lightning Protection Code.
NFPA 101: Life Safety Code.

NFPA 110: Emergency and Standby Power Systems.

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

F. Underwriters Laboratories Inc. (UL):

UL 57:	Electric Lighting Fixtures.
UL 96:	Lightning Protection Components.
UL 96A:	Installation Requirements for Lightning Protection Systems.
UL 98:	Enclosed and Dead-Front Switches.
UL 198E:	Class R Fuses.
UL 498:	Attachment Plugs and Receptacles.
UL 943:	Ground-Fault Circuit Interrupters.
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.

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 sizes 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

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. w 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.
3. 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.

2.4 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. Provide the following wire for direct buried grounds:
a. Bare, uncoated copper cable, unless otherwise noted.

b. Conductors composed of 98% IACS soft or annealed copper to conform to the following requirements:
   1) 250 kcmil stranded, unless otherwise noted.
   2) Solid conductors in sizes No. 4 AWG and smaller.
c. Sources: Anaconda; General Cable; General Electric; Triangle

3. 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.
4. 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

2.5 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.

2.6 MISCELLANEOUS
   1. 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 - 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 02220, 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 liquid tight galvanized flexible steel 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 1/2" 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 multiconductor 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. Rotate each ground rod 180° for every foot it is driven to prevent

undetected deflection. If it cannot be rotated, a new ground rod shall be driven.

7. 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.
8. Chemically degrease and dry connections completely before welding.
9. Apply one coat of asphaltic coating to all exothermic-welded connections to be buried.
10. 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.
11. A separate, continuous, insulated equipment grounding conductor shall be installed in all feeder and branch circuits.
12. A separate neutral conductor shall be installed for each branch circuit. Combining neutrals shall not be allowed.
13. Bond all insulated grounding bushings with a bare #6 AWG grounding conductor to a ground plate or ground bus.
14. Direct buried ground conductors shall be installed at a nominal depth of 30" below grade, unless noted otherwise.
15. 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.

A. 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 immediately 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.

3.1 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 16483

ADJUSTABLE FREQUENCY DRIVE

PART 1 GENERAL

1.1 SCOPE

A. The variable frequency drive shall be rated for 240 Vac single phase input with a 240Vac three phase output. This unit shall be sized for a 15 HP motor minimum or as recommended by the manufacturer, the larger of the two.

1.2 RELATED SECTIONS

1.3 REFERENCES

A. The adjustable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.
   1. Institute of Electrical and Electronic Engineers (IEEE)
      a. IEEE 519-1992: Guide for harmonic content and control
   2. Underwriters Laboratories (UL508C: Power Conversion Equipment)
      a. UL
      b. CUL
   3. National Electrical Manufacturer's Association (NEMA)
      a. ICS 7.0: Industrial Controls & Systems for AFD.
   4. IEC 61800-2 and –3. EN 50082-1 and –2
      a. Fulfill all EMC immunity requirements

B. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer.
   1. Dimensioned outline drawing.
   2. Control Schematic diagram.
   3. Power and control connection diagram(s)
   4. Letter of size recommendation from the manufacturer.

1.5 SUBMITTALS FOR INFORMATION

A. When requested by the Engineer the following product information shall be submitted:
   1. Product bulletins

2. Technical product data sheets
3. Harmonic analysis result

1.6 SUBMITTAL FOR CLOSE-OUT

A. The following information shall be submitted for record purposes prior to final payment.
   1. Final as-built drawings and information for items listed in Section 1.04.1.
   2. Installation information.

1.7 QUALIFICATIONS

A. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors, power distribution circuit breakers, when specified. These parts, when specified, shall have a commonality with other manufacturer's products.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 certified. All equipment shall have been tested and listed by UL as complying with the requirements of UL508C

C. The supplier of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Adjustable Frequency Drives shall be on the basis of Eaton Electrical HVX Series, Allen Bradley, or Siemens Robicon for function and quality. No "Approved Equal".

1.8 REGULATORY REQUIREMENTS

1.9 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.10 FIELD MEASUREMENTS

1.11 OPERATION AND MAINTENANCE MANUALS

A. Five (5) copies of the equipment operation and maintenance manuals shall be provided.

B. Operation and maintenance manuals shall include the following information:
   1. Instruction books
   2. Recommended renewal parts list.
   3. Drawings and information required by Section 1.04.3

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Eaton

B. Siemens Robicon

C. Allen Bradley

D. Naming specific venders does not imply acceptance of their standard products nor relieve them from meeting these specifications in their entirety.

2.2 ADJUSTABLE FREQUENCY DRIVES (AFD)

A. Where shown on the drawings, adjustable frequency drives 1 through 2000 Horsepower (HP) Variable Torque (VT) shall have the following features:
   1. The AFDs shall be rated for 240 Vac, single phase input with a 240 Vac three phase output. The AFD shall provide microprocessor based control for three-phase induction motors. The controller's full load output current rating shall be based on Variable Torque application at 40° C ambient and 1-16 kHz switching frequency below 50 HP and 1-10 kHz 50 HP and above to reduce motor noise and avoid increased motor losses.
   2. The AFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source AFD are not accepted. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not accepted. The AFD shall run at the above listed switching frequencies.
   3. The AFD shall have efficiency at full load and speed that exceeds 95% for AFD below 15 HP and 97% for drives 15 HP and above. The efficiency shall exceed 90% at 50% speed and load.
   4. The AFD shall maintain a minimum line side displacement power factor of 0.96, regardless of speed and load.
   5. The AFD shall have a one (1) minute overload current rating of 110% for variable torque applications.

6. The AFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the AFD.
7. The AFD shall have an integral EMI/RFI filter as standard.
8. The AFD shall limit harmonic distortion reflected onto the utility system to voltage and current levels as defined by IEEE 519-1992 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor. DC link chokes are not accepted.
9. The system containing the AFD shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the AFD provided with the standard input line reactor or optional input isolation transformer, the AFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier AC to DC conversion section with phase shifting transformer for all drives above 75 HP. This eighteen pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sinewave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not accepted above 75 HP.
10. The AFD shall be able to start into a spinning motor (flying start). The AFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the AFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
11. Standard operating conditions shall be:
    a. Incoming Power: single-phase, 240 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level. Output shall be 240Vac, three phase.
    b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
    c. Speed regulation of +/- 0.5% of base speed.
    d. Load inertia dependant carryover (ridethrough) during utility loss.
    e. Insensitive to input line rotation.
    f. Humidity: 0 to 95% (non-condensing and non-corrosive).
    g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
    h. Ambient Temperature: -10 to 40 °C (VT).
    i. Storage Temperature: -40 to 70 °C.
12. The AFD shall have the following system interfaces:
    a. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output,

and one (1) programmable analog output shall be provided, with the following available at minimum.

1) Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
    - Fault
    - Run
    - Ready

13. Monitoring and Displays
    a. The AFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
        1) Run
        2) Forward
        3) Reverse
        4) Stop
        5) Ready
        6) Alarm
        7) Fault
        8) Input/Output (I/O) Terminal
        9) Keypad
        10) Bus/communication
        11) Hand
        12) Auto
        13) Off
    b. The AFD keypad shall be capable of displaying the following monitoring functions at a minimum:
        1) Motor Speed (RPM and %)
        2) Frequency reference
        3) Output frequency
        4) Motor current
        5) Motor torque
        6) Motor power
        7) Motor voltage
        8) DC-link voltage
        9) Heatsink temperature
        10) Motor run time (resetable)
        11) Total operating days counter
        12) Operating hours (resetable)
        13) Total megawatt hours
        14) Megawatt hours (resetable)
        15) Voltage level of analog input
        16) Current level of analog input
        17) Digital inputs status
        18) Digital and relay outputs status
        19) Motor temperature rise

20) PID references
21) Protective Functions

c. The AFD shall include the following protective features at minimum:
1) Over-current
2) Over-voltage
3) System fault
4) Under-voltage
5) Input line supervision
6) Output phase supervision
7) Under-temperature
8) Over-temperature
9) Motor stalled
10) Motor over temperature
11) Motor under-load
12) Logic voltage failure
13) Microprocessor failure
14) Brake chopper supervision
15) DC Injection braking

d. The AFD shall provide ground fault protection during power-up, starting, and running. AFD with no ground fault protection during running are not accepted.

14. Diagnostic Features
a. Active Faults
b. The last 10 faults shall be recorded and stored in sequential order
c. Fault code and description of fault shall be displayed on the keypad.
d. Fault or alarm LED shall blink
e. Display drive data at time of fault
f. In the event several faults occur simultaneously, the sequence of active faults shall be viewable.
g. During a fault, the drive must be able to identify the following:
1) Drive Speed
2) Running hours
3) Running Days
4) Amps during fault
5) Motor Power
6) Motor Torque
7) DC bus Voltage
8) Drive Temperature
h. Fault History
1) The last 30 faults shall be recorded and stored in sequential order.
2) Display drive data at time of fault

15. Additional features included in the AFD:
    a. The following indicating lights shall be provided on the keypad.
        1) Drive Ready
        2) Drive Run
        3) Drive Fault
    b. The current withstand rating of the drive shall be 100,000 AIC. The rating of the complete drive assembly shall be UL tested and listed at 65kAIC.
    c. Communication card for interface with ModBus RTU control system.
    d. The AFD shall have a cooling fan that is field replaceable using non-screw accessibility.
16. Enclosure
    a. The AFD shall be designed in a NEMA Type 1 enclosure. Packaging of the drive shall be designed and manufactured by the manufacturer of the drive for quality assurance.
    b. The AFD shall have complete front accessibility with easily removable assemblies.
    c. Cable entry shall be bottom entry.

PART 3 EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.

2. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The Adjustable Frequency Drive shall trip electronically without device failure.

3. After all tests have been performed, each AFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.

4. After the burn-in cycle is complete, each AFD shall be put through a motor load test before inspection and shipping.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

C. All testing and manufacturing procedures shall be ISO 9001 certified.

3.2 INSTALLATION

A. Unit shall be installed in the pump control panel

3.3 FIELD QUALITY CONTROL

A. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the AFD in accordance with those instructions.

END OF SECTION

SECTION 16900

CONTROLS AND INSTRUMENTATION

PART 1GENERAL

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

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 panel. Include calculations for sizing the 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 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. Vulkene insulated switchboard wire. 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, 41 strand, 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. 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. Heineman Series CF, Curve 2, E-frame breaker, Weidmuller for each instrument system, or Engineer approved equal annunciator, lighting circuit, control system or similar major device requiring 24 or 115Vac power.
b. Heineman Series CF, Curve 3, Weidmuller, 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 neon coil energization indicator on 120Vac coils.
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 (480 V) 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.
3. The transformer rating shall be fully visible from the front when the unit door is opened.

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. The enclosure shall be sized for the heat rejection of the variable frequency drive for 105° air temperature.

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 undervoltage and an overvoltage for single phase pumpstation. 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 of 50°C, minimum.

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 stainless steel a 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. Each Flowmeter shall be aSiemens/Danfoss “Mag 3100 W” with “MAG 500” signal converter, or approval equal. Each Flowmeter shall be installed in a meter pit as indicated on the Drawings. Signal converter shall be installed as indicated and wired to a source of control power.

B. Meter Design Specifications:

1. Type: Sensor with ANSI Class 150 flanges
2. Body material: Carbon steel with 2-component coating
3. Connection Size: Required metering flow range:
   3" 1-250 gpm
4. Liner: Neoprene
5. Temperature rating of medium: 32 to 200 degF
6. Ambient temperature rating: -40 to 210 deg F
7. Operating pressure: 0.15 to 600 psia

8. Excitation rating: 3.125 Hz
9. Enclosure rating: NEMA 6
10. Earthing electrodes: AISI 316 Ti

C. Signal Converter Design Specifications:
1. Accuracy: 0.5%
2. Supply voltage 115-230V a.c.
3. Power consumption: 9 VA at 230V a.c.
4. Current outputs: 0-20 mA or 4-20 mA
5. Digital outputs: Active or passive
6. Relay output: One, adjustable function (error, direction /limit, etc.)
7. Totalizers: Two 8-digit counters; forward, net, or reverse flow
8. Display Backlit alphanumeric, 2 lines x 20 characters
Reverse flow indicated by negative sign.
9. Zero point adjustment: Automatic
10. Galvanic isolation: All inputs and outputs
11. Enclosure: Insert type for mounting through deadfront
IP 20 enclosure rating

D. Additional Features:
1. Flowmeter shall have a sensorprom unit which stores sensor calibration data and signal converter settings for the lifetime of the meter. At commissioning the flowmeter shall commence metering without any initial programming. User specified settings shall be downloadable to the sensorprom unit. If the signal converter ever needs to be replaced, the new converter shall be able to upload all previous settings and resume measurement without any need for programming.
2. Signal converter shall have the following functions: Flowrate, totalizer, low flow cut-off, empty pipe cut-off, flow direction (uni-or bi-directional), error system, operating time, limit switches, pulse output.
3. Equalization of sensor potential shall be accomplished effectively and completely. Manufacturer may offer built-in grounding electrodes for equalization. If this method does not prove adequate, a grounding flange shall be furnished, installed, and properly grounded and bonded at no additional cost to Owner.

2.4 CAPACITOR START KIT

A. Provide for each pump a capacitor start kit with starting and running capacitors. Capacitors shall be in separate enclosures for each pump within the panel enclosure. The kit shall be removable from the panel as a unit without the use of tools. Only provide if applicable for single phase.

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:

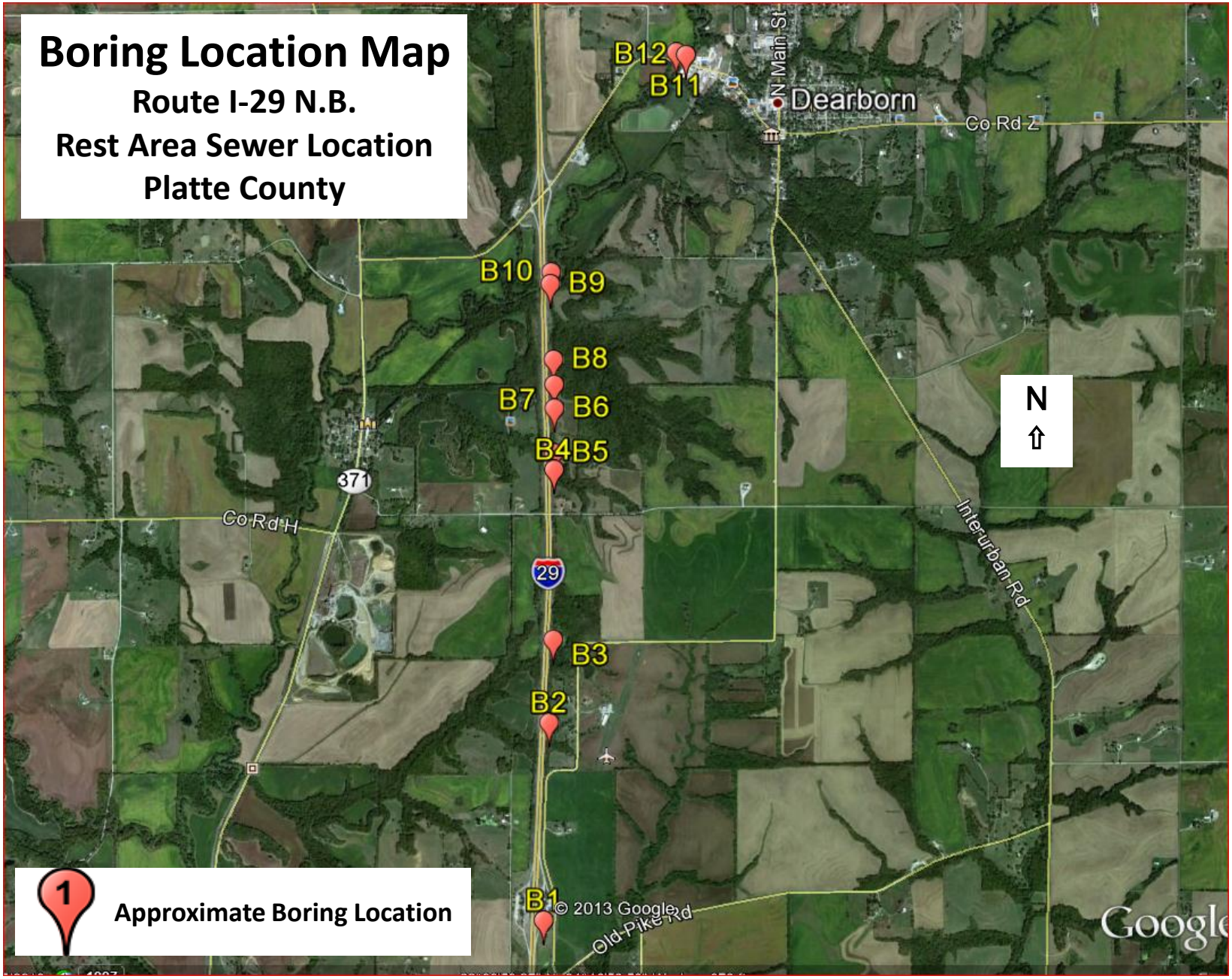
1. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections.
2. The control and instrumentation circuits shall be demonstrated to operate satisfactorily and to conform to contract documents.

C. System Functional Test:
1. Upon completion of equipment tests, a system functional test shall be performed.

END OF SECTION

APPENDIX A

GEOTECHNICAL REPORT BORING LOGS


Boring Location Map
Route I-29 N.B.
Rest Area Sewer Location
Platte County
B12
B11
N Main St
Dearborn
Co Rd Z
B10
B9
B8
B7
B6
B4
B5
371
Co Rd H
29
Interurban Rd
B3
B2
B1
Old Pike Rd
© 2013 Google
N
1
Approximate Boring Location

MISSOURI DEPARTMENT OF TRANSPORTATION
CONSTRUCTION AND MATERIALS
Subsurface Logs for Preliminary Geotechnical Report – Form M-42

County: Platte **Route:** I-29 N.B. R/W **Job Number:** Rest Area Sewer Line

Logged by: B. Harvel **Date Work Performed:** 3/19-3/20/2013

LOCATION	LOG OF MATERIALS		CLASSIFIED BY
B-1 *E. 2707803.2 *N. 1204801.8 Elev. 962.9	0-0.5' 0.5-7.5' 7.5-10.0' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Brown clay, moist. Reddish brown clay, moist.	Versa Drill 4000, TR-2 w/3" CFA
B-2 *E. 2707926.0 *N. 1208893.2 Elev. 947.9	0-0.5' 0.5-3.5' 3.5-10.2' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Tan to light brown clay, moist. Reddish brown clay, moist.	"
B-3 *E. 2708014.4 *N. 1210611.8 Elev. 955.0	0-0.5' 0.5-4.5' 4.5-7.5' 7.5-10.0' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Tan to light brown clay, moist. Brown clay, moist. Brownish gray weathered shale, dry.	"
B-4 *E. 2708042.8 *N. 1214130.1 Elev. 929.1	0-0.5' 0.5-10.0' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Brown clay, with some gravel from 3-4±' and at 6.5±', moist.	"
B-5 *E. 2708034.5 *N. 1214474.3 Elev. 933.5	0-0.5' 0.5-8.5' 8.5-10.0' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Dark brown clay, moist. Reddish brown clay, moist.	"
B-6 *E. 2708054.3 *N. 1215398.9 Elev. 953.7	0-0.5' 0.5-10.0' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Light brown to tan clay or possible shale,dry.	"
B-7 *E. 2708052.2 *N. 1215890.4 Elev. 966.6	0-0.5' 0.5-8.5' 8.5-10.0' Boring terminated at 10.0'	Dark brown clay with trace organics, moist. Light brown to tan clay, moist. Light brown weathered shale, moist.	"
B-8 *E. 2708038.1 *N. 1216408.3 Elev. 938.6	0-0.5' 0.5-6.5' 6.5-8.5' 8.5-10.0'	Dark brown clay with trace organics, moist. Tan to light brown clay, moist. Limestone cobble, cut with auger. Reddish brown clay, moist.	"

MISSOURI DEPARTMENT OF TRANSPORTATION
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County: Platte **Route:** I-29 N.B. R/W **Job Number:** Rest Area Sewer Line

Logged by: B. Harvel **Date Work Performed:** 3/19-3/20/2013

LOCATION		LOG OF MATERIALS	CLASSIFIED BY
B-9 *E. 2707975.8 *N. 1217984.6 Elev. 881.8	0-0.5' 0.5-1.5' 1.5-10.0'	Dark brown clay with trace organics and gravel, moist. Dark brown to black clay with gravel, moist. Light brown to tan clay, moist.	Versa Drill 4000, TR-2 w/3" CFA
		Boring terminated at 10.0'	
B-10 *E. 2707993.5 *N. 1218231.9 Elev. 865.5	0-0.5' 0.5-2.5' 2.5-10.0'	Dark brown clay with trace organics, moist. Brown clay, moist. Gray clay, moist.	"
		Boring terminated at 10.0'	
B-11 *E. 2710518.7 *N. 1222789.6 Elev. 873.9	0-0.5' 0.5-1.5' 1.5-2.0' 2.0-10.0'	Dark brown clay with trace organics, moist. Brown clay, moist. Cobbles, gravel and clay. Brown to dark gray clay, moist.	"
		Boring terminated at 10.0'	
B-12 *E. 2710716.1 *N. 1222732.4 Elev. 876.7	0-0.5' 0.5-3.5' 3.5-6.0' 6.0-10.0'	Dark brown clay with trace organics, moist. Brown clay, moist. Boulder. Brown clay, moist.	"