



TCRSD Technical Specifications

Helping to Preserve Our Natural Resources!

TECHNICAL SPECIFICATIONS

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SECTION 01010 – SUMMARY OF WORK

PART 1 – GENERAL

1.01 PROJECT DESCRIPTION

This Section includes basic identification of the work and other related activities.

- A. Project Name: TBD
- B. Owner's Name: Taney County Regional Sewer District
- C. Engineer's Name: TBD
- D. The Project includes all work for the components described in the following paragraphs:
 - 1. Construction of facility improvements as shown on the Drawings and described in these specifications. Major components include:
 - a. Installation of gravity sanitary sewer lines and manholes
 - b. Installation of force main sanitary sewer lines and appurtenances
 - c. Construction of non-clog submersible pump sanitary sewer lift stations
 - d. All other components shown on the Drawings and described in these specifications

1.02 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on the unit prices described in the Agreement.

1.03 CONTRACTOR'S DUTIES

- A. Except as specifically noted, provide and pay for:
 - 1. Labor, materials, and equipment.
 - 2. Tools, construction equipment, and machinery.
 - 3. Water, heat, and utilities required for construction.
 - 4. Other facilities and services necessary for proper execution and completion of work.
- B. Pay legally required sales, consumer, and use taxes.
- C. Secure and pay for as necessary for proper execution and completion of work, and as applicable at time of receipt of bids:
 - 1. Permits.
 - 2. Government fees.
 - 3. Licenses.
- D. Give required notices.
- E. Comply with codes, ordinances, rules, regulations, orders, and other legal requirements of public authorities that bear on performance of work.
- F. Promptly submit written notice to Engineer of observed variance of Contract Documents from legal requirements. It is the Contractor's responsibility to make certain that drawings and specifications comply with codes and regulations.
 - 1. Appropriate modifications to Contract Documents will adjust necessary changes.
 - 2. Assume responsibility for work known to be contrary to such requirements, without notice.
- G. Enforce strict discipline and good order among employees. Do not employ on work:

1. Unfit persons.
 2. Persons not skilled in assigned task.
- H. Comply with minimum wage requirements.
- I. Comply with nondiscrimination requirements.
- J. Perform all supervision and work necessary to provide safe working conditions for completion of all required excavation and construction work.
- K. Verify dimensions indicated on drawings with field dimensions before fabrication or ordering of materials. Do not scale drawings.
- L. Notify Engineer of existing conditions differing from those indicated on the Drawings. Do not remove or alter structural components without prior written approval.

1.04 CONTRACTOR USE OF PREMISES

- A. Confine Operations at site to areas permitted by:
1. Law.
 2. Ordinances.
 3. Permits.
 4. Contract Documents.
 5. Owner.
- B. Do not unreasonably encumber site with materials or equipment.
- C. Do not load structure with weight that will endanger structure.
- D. Assume full responsibility for protection and safekeeping of products stored on premises.
- E. Move any stored products that interfere with operations of Owner.
- F. Obtain and pay for use of additional storage or work areas needed for operations.
- G. Use of site. Exclusive and complete for execution of work, except:
1. Contractor shall maintain access to existing facilities.
- H. Operation of existing sewage facilities:
1. It is essential that the sewage service be maintained during the construction period. Short periods of shutdown will be possible to permit modifications or connections to or tie in with existing facilities. The time period will vary with Owner usage at different times of the day. Contractor is responsible for pumping, hauling, and treatment costs of sewage during the construction period.
 2. In some instances it will be necessary to complete and put new facilities into operation prior to commencing work on existing facilities which would require their removal from service.
 3. Where interruption of existing facilities are necessary, the Contractor is to plan his work in cooperation with Owner for the least possible disruption of service. When existing operation must be suspended because of the Contractor's work, he shall have all necessary materials and equipment on hand, and have ample work force available prior to beginning the work.

1.05 POSITION, GRADIENT, AND ALIGNMENT

- A. All construction work shall be done to the lines and grades shown on the Plans. The Engineer will establish control points on the site. Detailed survey and staking for location and grade of individual

structures or other construction, as well as measurements and elevations within structures, shall be performed by the Engineer as specified in the Supplementary Conditions.

- B. Any work done without being properly located and established by base lines, offset stakes, benchmarks, or other basic reference points, may be ordered removed and replaced at the Contractor's expense.

1.06 PROTECTION AND MAINTENANCE OF PUBLIC AND PRIVATE PROPERTY

- A. Protect, shore, brace, support, and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by the construction work performed. All pavement, surfacing, driveways, curbs, walks, buildings, signs, billboards, utility poles, guy wires, and other surface structures affected by construction operations in connection with the performance of the Contract shall be restored to the original condition thereof as determined and approved by the Engineer. All replacements of such underground construction and surface structures or parts thereof shall be made with new materials conforming to the requirements of these Specifications or, if not specified, as approved by the Engineer.
- B. The Contractor shall be responsible for all damage to streets, roads, highways, railroads, shoulders, ditches, embankments, culverts, bridges, power transmission lines, oil lines, gas lines, or other public or private property or facility, regardless of location or character, which may be caused by moving, hauling, or otherwise transporting equipment, materials, or men to or from the work or any part or site thereof, whether by him or his subcontractor or subcontractors. The Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction over, the damaged property or facility concerning its repair or replacement or payment of costs incurred in connection with said damage.

1.07 INSPECTION BY PUBLIC AGENCIES

- A. Authorized representatives of the Engineers and Owner shall have access to the work wherever it is in preparation or progress. The Contractor shall provide facilities for such access and inspection.

1.08 CONTRACTOR'S RESPONSIBILITY FOR MATERIALS

- A. The Contractor shall be responsible for the condition of all materials furnished by him, and he shall replace at his own cost and expense any and all such material found to be defective in design or manufacture, or which has been damaged after delivery. This includes the furnishing of all materials and labor required for replacement of any installed material which is found to be defective at any time prior to the expiration of 1 year from the date of final payment.

1.09 EXPLANATION OF PROPOSAL

- A. The Owner may award a contract to a qualified Bidder who, in the Owner's judgment, has submitted the lowest and most favorable responsive bid for the alternative(s) and option(s) that the Owner selects, if any. The Owner reserves the right to reject any or all Bids, to waive informalities, and to reject nonconforming, non-responsive, or conditional bids.

1.10 "OR EQUAL" STATEMENT

- A. When a manufacturer's name is used in these Specifications it is used to establish a standard and the words "or equal", if not stated, are implied.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 WORK RESTRICTIONS

- A. General: The Contractor shall limit his use of the premises to the work indicated, so as to allow for Owner occupancy and use by the public.
- B. Use of the Site: Confine operations at the site to the areas permitted under the Contract. Portions of the site beyond areas on which work is indicated are not to be disturbed. Conform to site rules and regulations affecting the work while engaged in project construction.
 - 1. Keep existing driveways and roadways open to traffic at all times. Coordinate open cut crossings of roads to allow at least one lane of through traffic at all times. Provide traffic control plan, to Engineer for approval, prior to beginning work in roadways and/or impacting traffic in any way.
 - 2. Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the areas indicated. If additional storage is necessary, obtain and pay for such storage off site.

END OF SECTION

SECTION 01025 – MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 SCOPE:

- A. This section covers methods of measurement and payment for items of work under this contract.

1.02 DEFINITION:

- A. Unit Price is stated on the Bid Form as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.03 PROCEDURES:

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, applicable taxes, and profit.
- B. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices. Measurements as determined by Owner shall be the final authority for payment at the established unit prices.
- C. List of Pay Items: A list of unit prices is included at the end of this Section.
- D. The quantities as given in the Bid Form are not guaranteed to be the exact or total quantities required for the completion of the Work shown on the drawings and described in the specifications. Increases or decreases may be made over or under the Bid Form estimated quantities to provide for the needs that are determined by the Owner during the process of the Work. Contract unit prices shall apply to such increased or decreased quantities. The Bidder is warned against unbalancing his bid, since the unit prices will apply to deductions as well as additions. The Owner has the privilege of omitting or adding to any unit items in the Bid Form.
- E. The Contractor agrees that he will make no claim for damages, anticipated profits, or otherwise, on account of any difference between the amounts of Work actually performed and materials actually furnished and the estimated amounts thereof. The Owner will not pay for or be responsible for unused materials which may have been ordered by the Contractor in accordance with the estimated quantities listed in the Bid Form.
- F. It is the intent of the Contract Documents that all costs in connection with the Work, including furnishing of all materials, equipment, supplies and appurtenances; providing all construction plant, equipment, and tools; and performing of all necessary labor to fully complete the Work, shall be included in the unit and lump sum prices named in the Bid Form. No item of Work that is required by the Contract Documents for the proper and successful completion of the Contract will be paid for outside of or in addition to the prices submitted in the Bid Form. All Work not specifically set forth in the Bid Form as a pay item shall be considered a subsidiary obligation of the Contract, and all cost in connection therewith shall be included in the prices named in the Bid Form.
- G. Even though the details for measurement and payment of a particular item are outlined in the following articles, if said item does not appear in the Bid Form, or if said item is a part of another item listed in the Bid Form, it will not be measured for payment.
- H. Whenever in the Bid Form there is a discrepancy between unit prices and extensions or totals, the

unit prices will govern, and the extensions or totals will be corrected accordingly.

- I. Items for payment will be measured in accordance with the stipulations of these specifications and as further shown on the drawings. Pay limits given are maximum, and where actual quantities of work items are less than as computed by said pay limits, the Contractor will be paid only for the actual quantities.

1.04 EXCAVATION AND TRENCHING:

- A. Except where otherwise specified, the unit or lump sum price bid for each item of work which involves excavation or trenching shall include all costs for such work and no direct payment will be made therefore. All excavation and trenching shall be unclassified as to materials which may be encountered. Trenches shall be unclassified as to depth.
- B. Rock Excavation:
 - 1. No separate payment will be made in connection with rock excavation as required. All costs in connection therewith shall be included in the unit price bid for the items affected thereby.

1.05 CLEARING AND GRUBBING:

- A. No separate payment for clearing and grubbing shall be made.

1.06 MISCELLANEOUS CONCRETE:

- A. No separate payment shall be made in connection with miscellaneous concrete. All costs associated with miscellaneous concrete shall be included in the unit price bid for pipe in place.

1.07 FENCES:

- A. No separate payment shall be made in connection with repair or replacement of existing fences. All costs associated with repair or replacement of existing fences shall be included in the unit price bid for pipe in place and site work.

1.08 UTILITIES:

- A. No separate payment shall be made in connection with repair, replacement, or relocation of existing utilities. All costs associated with repair or replacement of existing utilities shall be included in the unit price bid for pipe in place and site work.

1.09 TEMPORARY EROSION CONTROL, SILT SOXX, SILT FENCE:

- A. No separate payment shall be made in connection with temporary erosion control, silt soxx or silt fence. All cost associated with installation, maintenance and removal of temporary erosion control, silt soxx or silt fence shall be included in the unit price bid for pipe in place and manholes in place. Temporary erosion controls will be in place in areas of construction prior to beginning of construction.

1.10 TEMPORARY TRAFFIC CONTROL:

- A. No separate payment shall be made in connection with temporary traffic control. All cost associated with installation, maintenance and removal of temporary traffic control shall be included in the unit price bid for pipe in place and manholes in place.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 PAY ITEMS

1. Mobilization, Demobilization and Bonding: Shall be a maximum of 5% of the total contract amount and shall be considered to cover all expenses incurred for mobilization, demobilization, bonding, and project start up. Up to two-thirds of the lump sum price for this pay item can be requested upon production of all bonds and full mobilization on the job site is complete. The remaining portion of this can be payable upon 100% completion of project and the Contractor has completely demobilized from the jobsite.
2. 5-FT Diameter Precast Manhole Remove and Replace: Shall be measured for payment by the occurrence. All materials, standard manhole frame and cover or bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.
3. 8" Class 200, SDR 21 PVC Force Main: Shall be measured for payment by the linear foot along the stationing of the pipe as installed. Stationing along the axis of the pipe is developed by a horizontal projection of the sloped pipe. All necessary labor, materials, fittings, thrust blocks, delivery, all clearing and grubbing, trenching, all rock excavation, bedding, tracer wire, pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup, and testing shall be included in this unit price.
4. 6" In-Line Isolation Valve: Shall be measured for payment by the occurrence. All labor, materials, etc. necessary to install the in-line isolation valve just downstream of Lift Station #2 in the air release valve vault, complete and in place.
5. 8" In-Line Isolation Valve: Shall be measured for payment by the occurrence. All labor, materials, valve box, excavation, backfilling, etc. necessary to install the in-line isolation valve complete and in place.
6. Combination Air Vacuum/Release Valve Assembly: Shall be measured for payment by the occurrence. All labor, materials, concrete structure, excavation, backfilling, etc. necessary to install the air/vacuum release valve assembly complete and in place.
7. Gravity Flow Meter: Shall be measured for payment by the occurrence. All labor, materials, wiring, conduit, excavation, backfilling, etc. necessary to install the gravity flow meter assembly complete and in place.
8. 8" Magnetic Flowmeter (TCRSD owned): Shall be measured for payment by the occurrence. All labor, materials, concrete structure, electrical work, control panels, enclosures, excavation, backfilling, etc., necessary to install the flowmeter complete and in place shall be included in this unit price.
9. 10" Magnetic Flowmeter (Missouri-American Water owned): Shall be measured for payment by the occurrence. All labor, materials, concrete structure, electrical work, control panels, enclosures, excavation, backfilling, etc., necessary to install the flowmeter complete and in place shall be included in this unit price.
10. 14" Steel Casing Road Bore: Shall be measured for payment by the linear foot. All materials, labor, delivery, equipment, encasement pipe, casing spacers, end seals, bore pits, clearing and grubbing, excavation, testing, and cleanup necessary to construct the boring, complete.
11. Low Pressure Grinder Pump Connections: Shall be measured for payment by the occurrence. All labor, materials, excavation, bedding, backfilling, etc. necessary to make connection to the sewer main including up to 100 ft of 4" PVC pipe to connect to the existing service line into the septic tank, complete.
12. Simplex Grinder Pump Station: Shall be measured for payment by the occurrence. All labor, materials, wet well structure, pumps, controls, electrical work, excavation, backfilling, etc. necessary to install the grinder pump station complete and in place.
13. 4-FT Diameter Precast Standard Concrete Manhole (0 ft - 8 ft depth): Shall be measured for payment by the occurrence. All 4-FT diameter precast standard concrete manholes that are a total of 0 ft to 8 ft in overall depth as measured from the top of manhole elevation to the bottom of the base elevation as specified in the construction drawings shall be included in this pay item. All materials, standard manhole frame and cover or

bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.

14. 4-FT Diameter Precast Standard Concrete Manhole (8.1 ft - 12 ft depth): Shall be measured for payment by the occurrence. All 4-FT diameter precast standard concrete manholes that are a total of 8.1 ft to 12 ft in overall depth as measured from the top of manhole elevation to the bottom of the base elevation as specified in the construction drawings shall be included in this pay item. All materials, standard manhole frame and cover or bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.
15. 4-FT Diameter Precast Standard Concrete Manhole (12.1 ft - 16 ft depth): Shall be measured for payment by the occurrence. All 4-FT diameter precast standard concrete manholes that are a total of 12.1 ft to 16 ft in overall depth as measured from the top of manhole elevation to the bottom of the base elevation as specified in the construction drawings shall be included in this pay item. All materials, standard manhole frame and cover or bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.
16. 5-FT Diameter Precast Drop Concrete Manhole (8.1 ft - 12 ft depth): Shall be measured for payment by the occurrence. All 5-FT diameter precast drop concrete manholes that are a total of 8.1 ft to 12.0 ft in overall depth as measured from the top of manhole elevation to the bottom of the base elevation as specified in the construction drawings shall be included in this pay item. All materials, standard manhole frame and cover or bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.
17. 5-FT Diameter Precast Drop Concrete Manhole (12.1 ft - 16 ft depth): Shall be measured for payment by the occurrence. All 5-FT diameter precast drop concrete manholes that are a total of 12.1 ft to 16.0 ft in overall depth as measured from the top of manhole elevation to the bottom of the base elevation as specified in the construction drawings shall be included in this pay item. All materials, standard manhole frame and cover or bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.
18. 5-FT Diameter Precast Drop Concrete Manhole (16.1 ft - 20 ft depth): Shall be measured for payment by the occurrence. All 5-FT diameter precast drop concrete manholes that are a total of 16.1 ft to 20 ft in overall depth as measured from the top of manhole elevation to the bottom of the base elevation as specified in the construction drawings shall be included in this pay item. All materials, standard manhole frame and cover or bolt down frame and cover as shown on plans, excavation, backfill, labor, surface restoration, haul off and removal of debris and spoils, testing, and delivery, necessary to install said manhole shall be included in this unit price.
19. 8" SDR-35 PVC Gravity Sewer: Shall be measured for payment by the linear foot. Measurement shall be made from the centerline station of the upstream manhole to the centerline station of the downstream manhole minus one-half the inside diameter of the upstream manhole minus one-half the inside diameter of the downstream manhole. Stationing along the axis of the pipe is developed by a horizontal projection of the sloped pipe. All necessary labor, materials, delivery, all clearing and grubbing, trenching, all rock excavation, bedding, tracer wire, pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup, and testing, shall be included in this unit price.
20. 8" Class 200, SDR-21 PVC Gravity Sewer: Shall be measured for payment by the linear foot. Measurement shall be made from the centerline station of the upstream manhole to the centerline station of the downstream manhole minus one-half the inside diameter of the upstream manhole minus one-half the inside diameter of the downstream manhole. Stationing along the axis of the pipe is developed by a horizontal projection of the sloped pipe. All necessary labor, materials, delivery, all clearing and grubbing, trenching, all

rock excavation, bedding, tracer wire, pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup, and testing, shall be included in this unit price.

21. 10" SDR-35 PVC Gravity Sewer: Shall be measured for payment by the linear foot. Measurement shall be made from the centerline station of the upstream manhole to the centerline station of the downstream manhole minus one-half the inside diameter of the upstream manhole minus one-half the inside diameter of the downstream manhole. Stationing along the axis of the pipe is developed by a horizontal projection of the sloped pipe. All necessary labor, materials, delivery, all clearing and grubbing, trenching, all rock excavation, bedding, tracer wire, pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup, and testing, shall be included in this unit price.
22. 4" Service Lateral Connections: Shall be measured for payment by the occurrence. All labor, materials, excavation, bedding, backfilling, etc. necessary to install wye or tee and riser, complete. All materials, labor, backfill, equipment, disposal services, tank cleaning, etc. necessary for the closure in place of each septic tank removed from service is also included in this pay item.
23. 6" Service Lateral Connections: Shall be measured for payment by the occurrence. All labor, materials, excavation, bedding, backfilling, etc. necessary to install wye or tee and riser, complete. All materials, labor, backfill, equipment, disposal services, tank cleaning, etc. necessary for the closure in place of each septic tank removed from service is also included in this pay item.
24. 4" Schedule 40 PVC Gravity Service Lateral: Shall be measured for payment by the linear foot. Measurement shall be made along the axis of the pipe from the end of the fitting after the riser to the point of termination. All necessary, labor, materials, delivery, all clearing and grubbing, trenching, all rock excavation, bedding, tracer wire, pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup and testing, shall be included in this unit price.
25. 6" Schedule 40 PVC Gravity Service Lateral: Shall be measured for payment by the linear foot. Measurement shall be made along the axis of the pipe from the end of the fitting after the riser to the point of termination. All necessary, labor, materials, delivery, all clearing and grubbing, trenching, all rock excavation, bedding, tracer wire, pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup and testing, shall be included in this unit price.
26. 4" Two-Way Service Lateral Cleanout: Shall be measured for payment by the occurrence. All excavation, backfill, labor, materials, etc., necessary to install cleanout shall be included in this unit price, complete.
27. 6" Two-Way Service Lateral Cleanout: Shall be measured for payment by the occurrence. All excavation, backfill, labor, materials, etc., necessary to install cleanout shall be included in this unit price, complete.
28. 1.25" Schedule 80 PVC Low Pressure Sewer: Shall be measured for payment by the linear foot of the pipe as installed. Stationing along the axis of the pipe is developed by a horizontal projection of the sloped pipe. All necessary labor, materials, fittings, thrust blocks, delivery, all clearing and grubbing, trenching, all rock excavation, bedding, tracer wire pipe installation, backfilling as specified, haul off and removal of debris and spoils, cleanup, and testing shall be included in this unit price.
29. Concrete Roll Back Curb and Gutter: Shall be measured for payment by the linear foot. All necessary excavation, backfill, aggregate, fill for back slopes, labor, materials, etc. shall be included in this unit price.
30. Riprap: Shall be measured for payment by the square yard, measured horizontally along pipe axis from beginning station to ending station, times the approved width. All labor, materials, excavation, placement, etc. necessary to install the riprap, complete.
31. Septic Tank Pumping and Removal: Shall be measured for payment by the occurrence. All necessary excavation, backfill, labor, materials, etc., necessary to pump and remove existing septic tank shall be included in this unit price.
32. Concrete Pipe Encasement: Shall be measured for payment by the linear foot. All excavation, labor, materials, haul off and removal of debris and spoils, etc., necessary to install concrete encasement complete and in place shall be included in this unit price.

33. Concrete Slope Anchors: Shall be measured for payment by the occurrence. All excavation, labor, materials, haul off and removal of debris and spoils, etc., necessary to install concrete slope anchor complete and in place shall be included in this unit price.
34. Removal of Big Bear Estates WWTF: Shall be measured as a lump sum item of work including removal of all concrete, piping, mechanical equipment, etc., of the existing WWTF and disposal of said items offsite, in addition to pumping and backfilling as necessary to satisfy MoDNR requirements, and restoring property to lawn condition.
35. Removal of Big Bear Estates WWTF: Shall be measured as a lump sum item of work including removal of all concrete, piping, mechanical equipment, etc., of the existing WWTF and disposal of said items offsite, in addition to pumping and backfilling as necessary to satisfy MoDNR requirements, and restoring property to lawn condition.
36. Road Replacement, Asphalt: Shall be measured for payment by the ton. Payment shall be for all areas indicated for asphalt replacement. All necessary, labor, materials, excavation, grading, fill, aggregate, base, asphalt, testing, and cleanup to replace the asphalt surface in accordance with the plans and specifications shall be included in this unit price. Any area adjacent to a road requiring replacement that is disturbed due to construction shall be restored in accordance with specifications and shall be included in this unit price. Areas not indicated for replacement will not be paid for separately.

Adjustments will be made to the payments due the Contractor for any plant mix bituminous base, plant mix bituminous base, plant mix bituminous pavement, plant mix bituminous surface leveling and asphaltic concrete pavement that contains PG64-22, PG70-22, or PG76-22 when it has been determined that the monthly average price for the midpoint of the published prices of PG64-22 for St. Louis, Missouri area and Kansas City area has fluctuated from the monthly average price of the month the project was bid. The St. Louis, Missouri area and Kansas City area prices will be obtained from the Asphalt Weekly Monitor® published by Poten & Partners Inc. The monthly base price will be the price from the last published Asphalt Weekly Monitor®. The monthly base price shall apply to the payment estimates for the following month.

The adjusted contract unit price will be applied to the actual amount of asphalt binder used by the Contractor for all asphalt items that are set up by the wet ton mix. The percentage of virgin asphalt as shown in the job mix formula, will be the basis for adjustments for an asphalt mix type placed on the project during the monthly index period. The effective asphalt obtained from the use of recycled asphalt pavement (RAP), if approved, will not be eligible for adjustment. The base price index for PG64-22 will be applied to the asphalt mix for mixes using PG64-22, PG70-22, and PG76-22.

To determine the adjustment for any material specified in this provision the following formula will be used.

$$A = (B \times C) \times (D - E)$$

Where:

- A = Adjustment for mix placed during monthly average index period
- B = Tons of mix placed during the monthly average index period
- C = % of virgin asphalt binder, by weight (mass), based upon the total mixture approved for the project
- D = Monthly average price at time of placement
- E = Monthly average price at time of bid

The engineer will make adjustment payments, as defined above, for the applicable work completed during each month except for projects on which the contractor is being charged liquidated damages, due to working beyond the project completion date. In this case, the "D" value used for the price adjustment will be either the last "D" value prior to the date that liquidated damage assessment began or the current monthly "D" value, whichever is lower. If the contractor is being charged liquidated damages due to the contract being beyond project completion date and the current months "D" value results in a deduction, then the current monthly "D" value will be used.

37. Road Replacement, Gravel: Shall be measured for payment by square yard. Payment shall be for all areas indicated for gravel replacement. All necessary, labor, materials, excavation, grading, fill, base, testing, and cleanup to replace the gravel surface in accordance with the plans and specifications shall be included in this unit price. Any area adjacent to a road requiring replacement that is disturbed due to construction shall be restored in accordance with specifications and shall be included in this unit price. Areas not indicated for replacement will not be paid for separately.
38. Lift Station #1: Shall be measured as a lump sum item of work including furnishing and installation of the station with all appurtenances, all discharge piping from the pumps to the exit from the valve vault, ConShield additive in wet well and lid, all clearing and grubbing, trenching, all rock excavation, backfilling as specified, haul off and removal of debris and spoils, all site work, retaining wall, electrical and controls, scada system, generator, valving and piping, magnetic flow meter and concrete structure, canopies, fencing, access drive, manufacturer's services, project operation and maintenance manual, testing, and all other incidentals required to complete the facility ready for operation. Owner will provide the control panels for the contractor to install.
39. Lift Station #2: Shall be measured as a lump sum item of work including furnishing and installation of the station with all appurtenances, all discharge piping from the pumps to the exit from the flowmeter vault, ConShield additive in wet well and lid, all clearing and grubbing, trenching, all rock excavation, backfilling as specified, haul off and removal of debris and spoils, all site work, retaining wall, electrical and controls, scada system, generator, valving and piping, magnetic flow meter and concrete structure, canopies, fencing, access drive, manufacturer's services, project operation and maintenance manual, testing, and all other incidentals required to complete the facility ready for operation. Owner will provide the control panels for the contractor to install.
40. Final Seed, Fertilize, and Mulch: This item shall be measured for payment by the acre. All necessary labor, material, erosion control blankets, application and maintenance of the seed, fertilizer, and mulch shall be included in this unit price.

END OF SECTION

SECTION 01290 – PAYMENT PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.02 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Engineer and paid for by Owner.
 - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Forms: Use forms provided by Owner for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.
 - 1. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Engineer. One copy shall include waivers of lien and similar attachments if required.
 - 1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
 - 2. Electronic submittals are acceptable.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit partial release and waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment. A final release and lien waiver must be submitted with the final pay request.
- G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
 - 1. List of subcontractors.
 - 2. Schedule of Values.
 - 3. Contractor's Construction Schedule (preliminary if not final).
 - 4. Products list.
 - 5. Schedule of unit prices (if applicable).
 - 6. Submittals Schedule (preliminary if not final).
 - 7. List of Contractor's staff assignments.
 - 8. List of Contractor's principal consultants.
 - 9. Copies of building permits.
 - 10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 - 11. Initial progress report.
 - 12. Report of preconstruction conference.

13. Certificates of insurance and insurance policies.
 14. Performance and payment bonds.
 15. Data needed to acquire Owner's insurance.
 16. Initial settlement survey and damage report if required.
- H. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. Contractor's Affidavit of Payment of Debts and Claims.
 5. Contractor's Affidavit of Release of Liens.
 6. Consent of Surety to Final Payment.
 7. Evidence that claims have been settled.
 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 9. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01340 – COMPLIANCE SUBMITTALS

PART 1 – GENERAL

1.01 GENERAL

- A. This section specifies procedural requirements for non-administrative compliance submittals including shop drawings, product data, samples, miscellaneous, and closeout submittals.
- B. Compliance submittals are required to amplify, expand, and coordinate the information contained in the Contract Documents.
- C. Compliance Submittals are necessary:
 - 1. For the Engineer to determine that the equipment and materials conform with the design concept and comply with the intent of the Contract Documents.
 - 2. For the proper erection, installation, operation and maintenance of the equipment and materials which the Engineer will review for general content but not for substance.
 - 3. For the Engineer to determine what supports, anchorages, structural details, connections, and services are required for the equipment and materials, and the effects on contiguous or related structures, equipment, and materials.

1.01 SECTION INCLUDES

- A. Shop Drawings.
- B. Product Data.
- C. Samples.
- D. Miscellaneous Submittals.
- E. Closeout Submittals.
- F. Submittal Procedures.
- G. Re-Submittal Procedures.
- H. Engineer's Responsibilities.
- I. Distribution of Submittals after Review.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 SHOP DRAWINGS

- A. Shop drawings are technical drawings and data that have been specially prepared for the Project.
- B. A qualified detailer must prepare shop drawings.
- C. Shop drawings may include but are not limited to the following items:

1. Fabrication and installation drawings showing foundation details, anchor bolt sizes and locations, base plate sizes, location of Owner's connections and all clearances required for erection, operation, and disassembly for maintenance.
 2. Setting diagrams.
 3. Shopwork manufacturing instructions.
 4. Templates.
 5. Patterns.
 6. Coordination drawings (for use on-site).
 7. Design mix formulas.
 8. Contractor's engineering computations.
 9. Electrical routing drawings, internal wiring diagrams, one-line diagrams, etc.
- D. Identify details by reference to sheet and detail numbers shown on Contract Drawings.
- E. Standard information prepared without specific reference to the Project is not considered to be shop drawings.

3.02 PRODUCT DATA

- A. Product data includes standard printed information on manufactured products that is not original to the Project.
- B. Product data may include but are not limited to the following items:
1. Manufacturer's production specifications and installation instructions.
 2. Standard schematic drawings.
 3. Standard diagrams and illustrations.
 4. Standard schedules.
 5. Standard wiring diagrams.
 6. Catalog sheets and brochures.
 7. Printed performance curves and charts.
 8. Roughing-in diagram and templates.
 9. Standard color charts.
 10. Operational range diagrams.
 11. Mill reports.
 12. Standard product operating and maintenance manuals.
 13. Other standard descriptive data.
- C. Modify drawings to delete information that is not applicable to the Project.
- D. Supplement standard information to provide additional information that is applicable to the Project.
- E. Clearly mark each copy to identify pertinent materials, products, or models.
- F. Show dimensions and clearances required.
- G. Show performance characteristics and capacities.
- H. Show wiring diagrams and controls.

3.03 SAMPLES

- A. Samples are physical examples to illustrate materials, equipment or workmanship, and to establish standards by which completed work is judged.

- B. Samples may include but are not limited to the following items:
 - 1. Partial sections of manufacture's or fabricated work.
 - 2. Small cuts or containers of materials.
 - 3. Complete units of repetitively used materials.
 - 4. Swatches showing color, texture, and pattern.
 - 5. Color range sets.
 - 6. Units of work to be used for independent inspection and testing.
- C. Samples shall be submitted of sufficient size and quantity to clearly illustrate the functional characteristics of product or material with integrally related parts and attachment devices.
- D. Field samples and mock-ups shall be erected at the Project site at a location acceptable to Engineer.
- E. Construct each field sample or mock-up complete, including work of all trades required in finished work.
- F. After review, samples may be used in construction of the Project.

3.04 MISCELLANEOUS SUBMITTALS

- A. Miscellaneous submittals are work-related, non-administrative submittals that do not fit in the three previous categories.
- B. Miscellaneous submittals may include but are not limited to the following:
 - 1. Specially prepared and standard printed warranties.
 - 2. Maintenance agreements.
 - 3. Workmanship bonds.
 - 4. Survey data and reports.
 - 5. Project photographs.
 - 6. Testing and certification reports.
 - 7. Field measurement data.
 - 8. Keys and other security protection devices.
- C. Contractor shall provide property surveys, field measurements, quantitative records of actual work, damage surveys, and similar data as required by the individual sections of these specifications.
- D. Where submittal of a copy of standards is indicated and except where copies of standards are specified as an integral part of a "Product Data" submittal, submit a single copy of standards for the Engineer's use. Where workmanship, whether at the project site or elsewhere, is governed by a standard, furnish additional copies of the standard to fabricators, installers, and others involved in the performance of the work.

3.05 CLOSEOUT SUBMITTALS

- A. Refer to individual sections of these specifications for specific submittal requirements of project closeout information, materials, spare parts, extra and overrun stock, tools, maintenance devices, keys, and similar items. In addition to submittals required in individual specification sections, the following submittals are required:
 - 1. Record Documents: Furnish a set of original documents as maintained on the project site. Also provide 2 photographic copies of marked-up drawings.
 - 2. Following completion of the Work and prior to final payment, Contractor shall furnish those drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified and furnish additional copies for insertion in equipment instruction books as required. All such copies shall be clearly marked "AS CONSTRUCTED." Contractor shall

provide two photographic copies of each "AS CONSTRUCTED" submittal for use by the Owner.

3. Operating and Maintenance Manuals: Furnish 3 bound copies of operating data and maintenance manuals.

3.06 SUBMITTAL REQUIREMENTS

- A. Contractor shall prepare for Engineer's concurrence a schedule for submission of all compliance submittals specified or necessary for Engineer's approval of the use of equipment and materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance.
- B. Contractor's submittal schedule shall accompany the procurement schedule and work progress schedule submitted to the Engineer.
- C. Schedule all submissions to permit review, fabrication, and delivery in time to cause no delay in the Work of Contractor or his Subcontractors or any other applicable contractors.
- D. Contractor shall consult the requirements of the Contract Documents in establishing his schedule for submittals.
- E. The Contractor's submittal schedule shall indicate the anticipated dates of original submission for each item and Engineer's acceptance thereof, and shall be based upon at least one re-submission of each item.
- F. All submittals required prior to fabrication or manufacture shall be scheduled for submission sufficiently in advance of the installation dates for the corresponding items of materials or equipment. Submittals pertaining to storage, installation, and operation at the site shall be scheduled for Engineer's acceptance prior to delivery of the equipment or materials.
- G. The Contractor shall submit all submittals of equipment and materials furnished by Subcontractors, manufacturers, and suppliers to the Engineer.
- H. Submit number of copies of submittals that the Contractor requires for distribution plus three copies that will be retained by the Engineer.
- I. Submit number of Samples specified in each of the specification sections.
- J. Sequentially number transmittal forms.
- K. Deliver submittals to the Engineer at their business address.
- L. Accompany submittals with a transmittal letter, in duplicate, containing the following:
 1. Date.
 2. Project title and number.
 3. Contractor's name and address.
 4. The number of each Shop Drawing, Product Data, Sample, and Miscellaneous Submittal submitted.
 5. Specification section number and article number.
 6. Notification of deviations from Contract Documents.
 7. Other pertinent data.

Unidentifiable submittals will be returned for proper identification.

- M. Submittals shall include:
 1. Transmittal letter.
 2. Date and revision dates.
 3. Project title and number.

4. The names of:
 - a. Owner.
 - b. Engineer.
 - c. Contractor.
 - d. Subcontractor.
 - e. Supplier.
 - f. Manufacturer.
 - g. Separate detailer when pertinent.
 5. Identification of product or material.
 6. Relation to adjacent structure or materials.
 7. Field dimensions, clearly identified.
 8. Specification section number and article number.
 9. Applicable standards, such as ASTM number or Federal Specification.
 10. A blank space, 3 inches high by 5 inches wide, for the Engineer's stamp.
 11. Identification of deviations from Contract Documents.
 12. Contractor's stamp, initialed or signed, certifying review of submittal, verification of field measurements, and compliance with Contract Documents.
 13. Contractor's stamp of approval shall constitute a representation to the Owner and the Engineer that the Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or he assumes full responsibility for doing so, and that he has coordinated each submittal with the requirements of the Work and the Contract Documents.
- N. Data submitted shall be complete with respect to dimensions, design criteria, materials of construction, and the like to enable the Engineer to review the information effectively. Where standard drawings are furnished that cover a number of variations of the general class of equipment, each such drawing shall be individually annotated to describe exactly which parts of the drawing apply to the equipment being furnished. Such annotations shall also include proper identification of the submittal permanently attached to the drawing. Reproduction or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings, but will be acceptable when used by Contractor as a drawing upon which to indicate information on erection or to identify detail drawings.
- O. Equipment operation and maintenance manuals shall be prepared by the manufacturer with loose-leaf pages mounted in durable covers and shall include the following:
1. Index and tabs.
 2. Instructions for installation, start-up, operation, inspection, maintenance, parts lists, and recommended spare parts, and data sheets showing model numbers.
 3. Applicable drawings.
 4. Address, telephone number, and fax number of nearest manufacturer-authorized service facility.
 5. All additional data specified.
- P. If errors are discovered during manufacture or fabrication, the submittal shall be corrected and re-submitted for review.
- Q. No Work requiring a Compliance Submittal shall be commenced or shipped until the submittal has been stamped "Approved" or "Approved as Noted" by Engineer. The Contractor shall keep a copy of each compliance submittal in good order at the site.

3.07 RE-SUBMITTAL REQUIREMENTS

- A. Submittals shall be resubmitted the number of times required for Engineer's approval. Any need for re-submittals in excess of the number set forth in the acceptable schedule, or any other delay in obtaining acceptance of submittals, will not be grounds for extension of the Contract Time, provided that the Engineer completes his reviews within the times specified in the 'Engineer's Responsibilities'

described below.

- B. Submit number of copies of re-submittals that the Contractor requires for distribution plus three copies that will be retained by the Engineer.
- C. Re-submittals will include the original submittal number and a sequential alphabetic suffix.
- D. Revise initial drawings as required and re-submit as specified for initial submittal.
- E. Indicate on drawings any changes that have been made other than those requested by the Engineer.
- F. Submit new product data and samples as required for the initial submittal.

3.08 ENGINEER'S RESPONSIBILITIES

- A. Engineer will review and return submittals to Contractor with appropriate annotations. The Engineer is allowed 15 days for review of each submittal, excluding delivery time to and from the Contractor.
- B. Engineer will review instruction books and similar submittals for general content but not for substance. The approval for use of a separate item as such will not indicate approval for use of the assembly in which the item functions.
- C. Review for:
 - 1. Design concept of project.
 - 2. Information given in Contract Documents.
- D. Review of separate item does not constitute review of an assembly in which the item functions.
- E. Samples will be reviewed only for aesthetic, color, or finish selection.
- F. Engineer's review action stamp, appropriately completed, will appear on all Compliance Submittals of Contractor when returned by the Engineer.
- G. Return submittals to Contractor for distribution.
- H. Prints of accepted drawings transmitted for final distribution will not be further reviewed and are not to be revised.
- I. Engineer's acceptance of compliance submittals will not relieve the Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless the Contractor has in writing called the Engineer's attention to such deviation at the time of submission and the Engineer has given written approval to the specific deviation, nor shall any acceptance by the Engineer relieve the Contractor from responsibility for errors or omissions in compliance submittals.
- J. Compliance submittals not requested will not be recognized or processed by the Engineer.

3.09 DISTRIBUTION OF SUBMITTALS AFTER REVIEW

- A. Contractor shall distribute copies of compliance submittals that carry the Engineer's stamp to:
 - 1. Contractor's file.
 - 2. Job-site file.
 - 3. Record documents file.
 - 4. Subcontractors.
 - 5. Supplier.

6. Fabricator.
 7. Installer.
 8. Governing Authorities.
 9. Others as necessary for the proper performance of the Work.
- B. Contractor shall distribute samples as directed.
- C. Contractor shall instruct parties to promptly report any inability to comply with requirements.
- D. Contractor shall record distribution on transmittal forms.

END OF SECTION

SECTION 01500 – TEMPORARY FACILITIES AND CONTROLS

PART 1 – GENERAL

1.01 SUMMARY

- A. Specific administrative and procedural minimum actions are specified in this section, as extensions of provisions in General Conditions and other contract documents. The requirements have been included for special purposes and indicated. Nothing in this section is intended to limit types and amounts of temporary work required, and no omissions from this section will be recognized as an indication by Engineer that such temporary activity is not required for successful completion of the work and compliance with requirements of contract documents. Provisions of this section are applicable to, but not by way of limitation, utility services, construction facilities, security/protection provisions, and support facilities.

1.02 QUALITY ASSURANCE

- A. In addition to compliance with governing regulations and rules/recommendations of franchised utility companies, comply with specific requirements indicated and with applicable local industry standards for construction work.
- B. ANSI Standards: Comply with applicable provisions of ANSI A10-Series standards on construction safety.
- C. Conservation: In compliance with Owner's policy on energy/materials conservation, install and operate temporary facilities and perform construction activities in a manner which reasonably will be conservative and avoid waste of energy and materials including water.

1.03 JOB CONDITIONS

- A. Establish and initiate use of each temporary facility at time first reasonably required for proper performance of the work. Terminate use and remove facilities at earliest reasonable time, when no longer needed or when permanent facilities have, with authorized use, replaced the need.
- B. Install, operate, maintain and protect temporary facilities in a manner and at locations which will be safe, non-hazardous, sanitary and protective of persons and property, and free of deleterious effects.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 TEMPORARY UTILITY SERVICES

- A. The types of services required include, but not by way of limitation, water, sewerage, surface drainage, electrical power and telephones. Where possible and reasonable, connect to existing franchised utilities for required services; and comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- B. Potable Water: It is the responsibility of the Contractor to obtain potable water when necessary.
- C. Non-Potable Water: Where non-potable water is used, mark each outlet with adequate health hazard warning signs.

- D. Temporary Power: Provide service with ground-fault circuit interrupter features, activated from each circuit of 20 amp or less rating.
- E. Metering: Provide meters for water and electrical power services. Read meters and record readings weekly and include in progress report to Engineer at monthly intervals.

3.02 TEMPORARY UTILITY SERVICES

- A. The types of temporary construction facilities required include, but not by way of limitation, water distribution, drainage, dewatering equipment, enclosure of work, heat, ventilation, electrical power distribution, lighting, hoisting facilities, stairs, ladders, and roads. Provide facilities reasonably required to perform construction operation properly and adequately.
- B. Water Distribution: Provide hose lengths sufficient to reach entire area of construction work, not less than ¾" hose size. Prevent freezing of water distribution by either prompt drainage after each use, or by suitable protection. Maintain 30 psi minimum water pressure at hose outlets, by temporary pumping where necessary.
- C. Enclosure: Provide temporary enclosure where indicated and where reasonably required to ensure adequate workmanship and protection from weather and unsatisfactory ambient conditions for work, including enclosure where temporary heat is used. Provide fire-retardant treated lumber and plywood. Provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship and reduce use of temporary lighting.
- D. Heating: Use steam or hot water where available and, where not available, use gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approved labels appropriate for application. Vent fuel-burning heaters, and equipment units with individual space thermostatic controls. Use electric-resistance space heaters only where no other more energy-efficient type of heater is available and allowable.
- E. Electric power: Provide weatherproof, grounded power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up testing of permanent electric-powered equipment prior to its permanent connection to electrical system.
 - 1. Supply power for electric welding, if any, from either temporary power distribution system or by engine-driven- power-generator sets, at Contractor's option.
- F. Lighting: Provide sufficient temporary lighting to ensure proper workmanship everywhere: by combined use of daylight, general lighting, and portable plug-in task lighting. Provide general lighting with local switching which will enable energy conservation during periods of varying activity (work-in-progress, traffic only, security check, lock-up, etc.).
- G. Access Provisions: Provide ramps, stairs, ladders and similar temporary access elements as reasonably required to perform the work and facilitate its inspection during installation. Comply with reasonable requests of governing authorities performing inspection. When permanent stairs are available for access during construction, cover finished surface with sufficient protection to ensure freedom from damage and deterioration at time of substantial completion.
- H. Roads: Except as otherwise indicated, develop subgrade and subbase of permanent roadways at earliest possible date and provide temporary surfacing to serve as temporary roads during construction. Surface sufficiently to provide all-weather, uninterrupted access to construction area,

for every form of transportation which can reasonably be expected. Maintain temporary roads during construction site as reasonably required to accommodate construction activities. When no longer needed as temporary roadways, remove temporary surfacing and restore subbases to conditions required by Contract Documents for permanent development.

3.03 SECURITY/PROTECTION PROVISIONS

- A. The types of temporary security and protection provisions required include, but not by way of limitation, fire protection, barricades, warning signs/lights, site enclosure fence, sidewalk bridges, building enclosure/lockup, watchman service, personnel security program (theft prevention), environmental protection, and similar provisions intended to minimize property losses, personal injuries and claims for damages at project site. Provide security/protection services and systems in coordination with activities in a manner to achieve 24-hour, 7-day-per-week effectiveness.
- B. Fire Extinguishers: Provide types, sizes, numbers and locations as would be reasonably effective in extinguishing fires during early stages, by personnel at project site. Provide Type A extinguishers at locations of low-potential for either electrical or grease-oil-flammable liquids fires; provide Type ABC dry chemical extinguishers at other location; comply with recommendations of NFPA No. 10. Post warning and quick instructions at each extinguisher location, and instruct personnel at project site, at time of their first arrival, on proper use of extinguishers and other available facilities at project site. Post local fire department call number on each telephone instrument at project site.
- C. Environmental Protection Procedures: Provide facilities, establish procedures, and conduct construction activities in a manner which will ensure compliance with regulations controlling construction activities at project site. Designate one person, the Construction Superintendent or other, to enforce strict discipline on activities related to generation of wastes, pollution of air/water/soil, generation of noise, and similar harmful or deleterious effects which might violate regulations or reasonably irritate persons at or in vicinity of project site.

3.04 TEMPORARY SUPPORT FACILITIES

- A. The types of temporary support facilities required include, but not by way of limitation, storage sheds, fabrication sheds, sanitary facilities, drinking water, first aid facilities, bulletin board, private and public telephones, clocks, thermometer, project identification signs, clean-up facilities, waste disposal services, rodent/pest control and similar miscellaneous general services, all as may be reasonably required for proficient performance of the work and accommodation of personnel at the site including Owner's and Engineer's personnel. Discontinue and remove temporary support facilities and make incidental similar use of permanent work of the project, only when and in manner authorized by Engineer, and, if not otherwise indicated, immediately before time of substantial completion. Locate temporary support facilities for convenience of users and for minimum interference with construction activities.
- B. Sanitary Facilities: Contractor to provide either piped toilet facilities or self-contained toilet units of type acceptable to governing authorities, adequate (at all stages of construction) for use of personnel at project site.
- C. Drinking Water: Provide drinking water, ice or power-cooled, adequate in number and locations for personnel at the project site. Furnish paper cups and waste receptacles.
- D. Collection and Disposal of Wastes:
 - 1. Establish a system for regular collection and disposal of waste materials from construction areas and elsewhere on the site. Enforce requirements strictly. Do not hold collected materials at the site longer than 7 days during normal weather or 3 days when the daily temperature is expected to rise above 80°F. Handle waste materials that are hazardous, dangerous, or unsanitary

separately from other inert waste by containerizing appropriately. Dispose of waste material in a lawful manner.

- a. Burying or burning of waste materials on the site will not be permitted.
- b. Washing waste materials down sewers or into waterways will not be permitted.
- c. Provide rodent-proof container to encourage depositing of garbage and similar wastes by construction personnel.

END OF SECTION

SECTION 01770 – CLOSEOUT PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Project Record Documents.
 - 3. Warranties.
 - 4. Final cleaning.

1.02 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 7. Complete startup testing of systems.
 - 8. Submit test/adjust/balance records.
 - 9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 - 11. Complete final cleaning requirements, including touchup painting.
 - 12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 - 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.03 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
 - 1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
 - 2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.04 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Owner.
 - d. Name of Engineer.
 - e. Name of Contractor.
 - f. Page number.

1.05 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.

- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, Record Drawings, and Record Specifications, where applicable.
- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.06 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 – EXECUTION

3.01 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - g. Remove labels that are not permanent.
 - h. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - i. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - i. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - j. Replace parts subject to unusual operating conditions.
 - k. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - l. Leave Project clean and ready for owner's use.
- C. Comply with safety standards for cleaning. Do not burn waste materials at the site. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION

SECTION 02115 – DUST AND EROSION CONTROL

PART 1 – GENERAL

1.01 SUMMARY

- A. This item shall consist of temporary control measures during the life of the construction contract to control air pollution, soil erosion, and siltation through the use of berms, dikes, dams, sediment basins, fiber mats, gravel mulches, grasses, slope drains, and other erosion control devices or methods.
- B. The Contractor is responsible for controlling erosion and discharge of sediment from the site at all times during construction. The Contractor shall provide necessary measures during all phases of his/her operations regardless of whether they are specifically noted on the Drawings and shall maintain and replace controls as necessary during the course of his/her operations.
- C. The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.
- D. Temporary control may include work outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.
- E. The Contractor shall clean streets both interior and adjacent to the site as needed after each rainfall, and at the end of construction.
- F. The Contractor is responsible for cleaning silt from storm drains prior to approval of construction.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. All materials shall meet commercial grade standards and shall be approved by the Engineer before being incorporated into the project.
- B. Grass. Grass which will not compete with the grasses sown later for permanent cover shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover.
- C. Mulches. Mulches may be hay, straw fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials.
- D. Fertilizer. Fertilizer shall be a standard commercial grade and shall conform to all Federal and state regulations and to the standards of the Association of Official Agricultural Chemists.
- E. Slope Drains. Slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, bituminous concrete, or other materials that will adequately control erosion.

PART 3 – EXECUTION

3.01 GENERAL

- A. In the event of a conflict between these requirements and pollution control laws, rules, or regulations of other Federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

- B. The Contractor shall be responsible for assuring compliance to the extent that construction practices, construction operations, and construction work are involved.

3.02 SCHEDULE

- A. Prior to the start of construction, the Contractor shall submit schedules for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the Engineer.
- B. Temporary construction entrance(s) and silt fences, straw bale dikes, or other initial sediment controls shown on the Drawings must be installed prior to any other work.
- C. Sediment basins must be installed within 10 calendar days after construction begins or as soon as 2 or more acres are disturbed, whichever comes first.

3.03 METHODS

- A. Several methods of controlling dust and other pollutants include, but are not limited to, the following:
 - 1. Exposing the minimum area of erodible earth.
 - 2. Applying temporary mulch with or without seeding.
 - 3. Using water sprinkler trucks.
 - 4. Using covered haul trucks.
 - 5. Using dust palliatives or penetration asphalt on haul roads.
 - 6. Using plastic sheet coverings.
 - 7. Using gravel.

3.04 AUTHORITY OF ENGINEER

- A. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, to limit the surface area of erodible earth material exposed by excavation, borrow and fill operations, and to direct the Contractor to provide immediate permanent or temporary erosion control measures to minimize loss of soil due to erosion and contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment.

3.05 CONSTRUCTION DETAILS

- A. Prior to clearing and grubbing operations for the project, Contractor shall identify all areas where the potential for loss of soil due to erosion exists, and shall line the construction side of the creek within these areas with straw bales to minimize eroded materials from entering the creek. These shall be maintained throughout the construction period and removed when the permanent ground covering is established. The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practical time as outlined in the accepted schedule. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

- B. When erosion is likely to be a problem, clearing and grubbing operations should be scheduled and performed so that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages.
- C. The Engineer will limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- D. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as part of the work as scheduled or are ordered by the Engineer, such work shall be performed by the Contractor at his/her own expense.
- E. The Engineer may increase or decrease the area of erodible earth material to be exposed at one time as determined by analysis of project conditions.

END OF SECTION

SECTION 02230 – SITE CLEARING

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Protecting existing trees and vegetation to remain.
 - 2. Removing trees and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Topsoil stripping.
 - 5. Removing above-grade site improvements.
 - 6. Disconnecting, capping or sealing, and abandoning site utilities in place.
 - 7. Disconnecting, capping or sealing, and removing site utilities.

1.02 DEFINITIONS

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 3 percent organic material content; free of subsoil, clay lumps, gravel, stones, and other objects more than 1 inch in diameter in any dimension; and free of weeds, roots, and other deleterious materials harmful to plant growth. Topsoil shall contain less than 5% by volume of stones, rocks, and gravel.
 - 1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Where surface soils do not meet the requirements of section 1.02.A of this specification and/or where quantities of surface soils that do meet section 1.02.A of this specification are insufficient use imported or manufactured soils from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

1.03 MATERIALS OWNERSHIP

- A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

1.04 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings according to Division 1.
 - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.05 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Notify utility locator service for area where Project is located before site clearing.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TREE PROTECTION

- A. Trees within permanent easements may be removed unless noted otherwise. Trees within temporary easements shall be removed only with approval of engineer and Owner as required for construction. Trees within the county right-of-way shall be removed only with approval of Engineer and Taney County Road and Bridge Department as required for construction.
- B. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
- C. Do not excavate within drip line of trees, unless otherwise indicated.
- D. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
 - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 - 4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.
- E. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
 - 1. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.03 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange to shut off indicated utilities with utility companies.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

3.04 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 - 4. Use only hand methods for grubbing within drip line of remaining trees.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding 8-inch loose depth, and compact each layer to a density equal to adjacent original ground.

3.05 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within drip line of remaining trees.
 - 3. Stockpile surplus topsoil and allow for resspreading deeper topsoil.

3.06 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.07 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 02300 – EARTHWORK

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns, and plantings.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for slabs-on-grade.
 - 4. Subbase course for concrete walks and pavements.
 - 5. Base course for asphalt paving.
 - 6. Subsurface drainage backfill for walls and trenches.
 - 7. Excavating and backfilling trenches within building lines.
 - 8. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.02 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Layer placed between the subbase course and asphalt paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations.
 - 1. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- K. Utilities include on-site underground pipes, conduits, ducts, and cables.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of plastic warning tape.
 - 2. Drainage fabric.
 - 3. Separation fabric.
- B. Samples: For the following:
 - 1. 30-lb samples, sealed in airtight containers, of each proposed soil material from on-site or borrow sources.
 - 2. 12-by-12-inch sample of drainage fabric.
 - 3. 12-by-12-inch sample of separation fabric.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

1.04 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

1.05 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 – PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Includes suitable approved materials from excavations and borrow areas(s). Shall be friable sandy or silty clay containing fine material sufficient to provide dense mass free of voids and capable of satisfactory compaction. Shall be free of roots or other organic matter, refuse, cinders, ice, snow, frozen earth, or other unsuitable matter. Do not use material containing gravel, stones, or shale particles greater in dimension than one-half the depth of the layer to be compacted. No rock greater than one (1) foot, measured along its longest axis, shall be placed within two (2) feet of the top of a pipe in any backfill. No rocks greater than one (1) foot will be allowed in the backfill above service line terminations, tees and wyes. No rock greater than one (1) foot, measured along its longest axis, shall be placed within two (2) feet of a structure.

- C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Backfill and Fill: Satisfactory soil materials.
- E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2- inch sieve and not more than 12 percent passing a No. 200 sieve.
- F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- H. Bedding: Embedment for ordinary trench conditions for eight-inch (8") nominal diameter through fifteen-inch (15") nominal diameter PVC gravity sewer line is compacted ASTM D2487 Class IB dense graded, clean, manufactured and processed aggregates described as angular crushed stone, crushed rock, crushed gravel, or crushed stone/sand mixtures containing little or no fines with gradations selected to minimize migration of adjacent soils with amounts finer than each square opening laboratory sieve as mass percent of 100 percent passing a 3/4-inch sieve, 30-55 percent passing a 1/2-inch sieve, 0-15 percent passing a No. 4 sieve, and 0-5 percent passing a No. 8 sieve compacted to 85% or greater standard proctor density and tested to ensure proper compaction.

<u>Sieve</u>	<u>% Passing</u>
¾"	100
½"	30-55
No. 4	0-15
No. 8	0-5

- I. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve.
- J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- L. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 3 percent organic material content; free of subsoil, clay lumps, gravel, stones, and other objects more than 1 inch in diameter in any dimension; and free of weeds, roots, and other deleterious materials harmful to plant growth. Topsoil shall contain less than 5% by volume of stones, rocks, and gravel.
 - 1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Where surface soils do not meet the requirements of this section and/or where quantities of surface soils that do meet this section of this specification are insufficient, use imported or

manufactured soils from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.02 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.
- B. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
 - 1. Grab Tensile Strength: 110 lbf; ASTM D 4632.
 - 2. Tear Strength: 40 lbf; ASTM D 4533.
 - 3. Puncture Resistance: 50 lbf; ASTM D 4833.
 - 4. Water Flow Rate: 150 gpm per sq. ft.; ASTM D 4491.
 - 5. Apparent Opening Size: No. 50; ASTM D 4751.
- C. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
 - 1. Grab Tensile Strength: 200 lbf; ASTM D 4632.
 - 2. Tear Strength: 75 lbf; ASTM D 4533.
 - 3. Puncture Resistance: 90 lbf; ASTM D 4833.
 - 4. Water Flow Rate: 4 gpm per sq. ft.; ASTM D 4491.
 - 5. Apparent Opening Size: No. 30; ASTM D 4751.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 BLASTING

- A. The Contractor shall submit a site plan indicating the following:
 1. Location and number of magazines.
 2. Bunkers, if required.
 3. Distance to adjacent buildings, structures, wells and other pertinent facilities.
- B. MSDS sheets shall be provided for all materials used on the job site.
- C. No blasting material shall be stored on-site.
- D. The equipment, processes and operations involving the manufacture, possession, storage, sale, transportation, maintenance and use of explosive materials shall comply with the requirements of Chapter 23 and the provisions of this chapter, NfiPA 495, ATF publication 5400.7 (6/90) and DOT 49 CFR listed in Chapter 44.
- E. Scope: The equipment, processes and operations involving the manufacture, possession, storage, sale, transportation, maintenance and use of explosive materials shall comply with the requirements of Chapter 23 and the provisions of this chapter, NfiPA 495, ATF publication 5400.7 (6/90) and DOT 49 CFR listed in Chapter 44.
- F. The Contractor shall meet the requirements as set out in NfiPA 495, sections 2-4.1 and 2-4.2.
- G. A contractor who has successfully completed a blasters certification course by ISEE (International Society of Explosive Engineers), MPLA (Missouri Limestone Producers Association) or another recognized testing agency and has kept the certification current will be considered as having fulfilled the requirements of NFPA 495 section 2-4.2.
- H. Required Insurance Coverage: The blasting contractor or operator of a facility engaged in blasting shall provide proof of insurance for blasting liability in the amount of no less than \$1,000,000 per incident and \$2,000,000 per project on an occurrence basis.
- I. Blasting Limits: Blasting will be allowed on this project in accordance with Section 3.03 of this specification.
- J. Time: Blasting shall be conducted only between the hours of 8:00 a.m. and 5:00 p.m. Monday through Friday, unless otherwise approved by the Owner.
- K. Signage: For electrically initiated blasts or blasts which may be affected by two-way radios or cellular phones, proper signage shall be set on all streets, roads or highways within one thousand (1000) feet of the blast area, unless otherwise approved by the Engineer, declaring "BLAST AREA TURN OFF TWO-WAY RADIOS AND NO CELLULAR PHONE USAGE". For other blasting proper signage shall be set on all streets, roads or highways within one thousand (1,000) feet of the blast area, unless otherwise approved by the Engineer, declaring "BLAST AREA."
- L. Seismographs:
 1. A minimum of one (1) seismograph shall be used on all blasting areas. The Engineer may require additional seismographs.

2. Seismic reading shall not exceed 1.0 IPS (Inches Per Second) at the closest structure or well.
 3. Sound levels shall not exceed 140 decibels at the seismic area.
 4. Weekly seismic readings and copies of the blasting log shall be provided to the Engineer unless more frequent readings and logs are requested.
- M. Pre-Blast Survey: A pre-blast survey shall be conducted by an independent contractor/ consultant and shall be the documentation of the existing conditions of a structure or well. The survey is used to determine whether subsequent blasting caused damage to the structure or well. Blasters shall be responsible for conducting pre-blast surveys when blasting within three hundred (300) feet of any habitable structure, well, road or highway.
1. The pre-blast survey for a well shall document:
 2. The casing count of the well.
 3. Total depth of the well.
 4. Static level of the well.
 5. The results of a pump test.
- N. Written Notice: Written notice shall be delivered to all property owners/managers within the pre-blast survey area and shall contain at a minimum:
1. Blasting contractor's or facility operator's name, address, and phone number.
 2. Starting and ending dates of blasting.
 3. Approximate times of day blasting will occur.
 4. Location of blasting and for whom the work is being done.
- O. Fly Rock: No fly rock shall leave the immediate blast area. On special occasions it may be necessary to cover the shot to prevent fly rock from leaving the blast area.
- P. Warnings/Blasting:
WARNINGS SHALL BE SOUNDED AS FOLLOWS:
1. The blasting contractor or facility operator shall be responsible for insuring that the blast area is visually inspected and made clear of people and/or animals before each shot.
 2. Three (3) 5 to 10 second soundings from a siren, air horn or other approved warning device, with a minimum sound level of 140 decibels at one hundred (100) feet shall be sounded.
 3. WAIT a full thirty (30) seconds.
 4. Sound another 5 to 10 second sounding.
 5. Immediately following the two (2) 5 to 10 second soundings give a VOICE COMMAND from an amplified bullhorn or equal stating "DETONATION TO FOLLOW."
 6. No person shall enter the blast area until such time that the blaster in charge has determined that no danger exists.
 7. An "ALL CLEAR" voice command shall be given after the blast and when the blast area is safe to enter for inspection.
- Q. Rock Excavation:
1. The maximum allowable rock size after blasting shall be no larger than 3' x 3' x 3'.
 2. All blasting is performed at the Contractor's sole risk. The Contractor is solely responsible for any and all damages caused by blasting to any adjacent structure or any other underground facilities. If damage does occur to any above or below ground facilities the Contractor is fully liable.
 3. All excavation is considered unclassified. No payment shall be made for rock encountered. Presence of rock shall not relieve Contractor of depth requirements.
 4. In high hazard areas, rock shall be removed by jackhammering as necessary. No payment to be made for removal of rock, including that which cannot be blasted. Contractor shall make determination of whether or not rock can be blasted, but Contractor shall be fully liable for any damages.

3.04 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete form work, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated. Do not disturb bottom of excavations intended for bearing surface.

3.06 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.07 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (whichever is the shorter) shall be the maximum length of open trench permitted on any line under construction.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
- C. Trench Bottoms: Excavate trenches 6 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Only sewer lines shall be placed in the Owner's trench. No other utilities will be permitted inside the trench.

3.08 APPROVAL OF SUBGRADE

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
 - 1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

3.09 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Engineer.
 - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for record documents.
 - 3. Inspecting and testing underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Backfill trenches excavated under footings and within 18 inches of bottom of footings; fill with concrete to elevation of bottom of footings.
- C. Place and compact initial backfill of bedding material, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- D. Coordinate backfilling with utilities testing.
- E. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.
- F. For areas not under pavement, place and compact final backfill of satisfactory soil material to final subgrade.
- G. For areas under pavement, place and compact final backfill using bedding material to final subgrade.

- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- C. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.

3.14 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. No rock greater than one (1) foot, measured along its longest axis, shall be placed within two (2) feet of any structure.
- C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material at 95 percent.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 92 percent.
 - 3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 85 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a 6-inch course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 12 inches of filter material and wrap in drainage fabric, overlapping sides and ends at least 6 inches.
 - 1. Compact each course of filter material to 95 percent of maximum dry unit weight according to ASTM D 698.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 6 inches.
 - 1. Compact each course of filter material to 95 percent of maximum dry density according to ASTM D 698.
 - 2. Place and compact impervious fill material over drainage backfill to final subgrade.

3.18 SUBBASE AND BASE COURSES

- A. Under pavements and walks, place subbase course on prepared subgrade and as follows:
 - 1. Place base course material over subbase.
 - 2. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
 - 3. Shape subbase and base to required crown elevations and cross-slope grades.
 - 4. When thickness of compacted subbase or base course is 6 inches or less, place materials in a single layer.
 - 5. When thickness of compacted subbase or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.
- B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.19 DRAINAGE COURSE

- A. Under slabs-on-grade, place drainage course on prepared subgrade and as follows:
 - 1. Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
 - 2. When compacted thickness of drainage course is 6 inches or less, place materials in a single layer.
 - 3. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet or less of wall length, but no fewer than two tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses (1 year), remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

3.23 TRENCH SETTLEMENT

- A. Any settlement of the trench within the warranty period for the project will be corrected by the contractor at his own expense.

END OF SECTION

SECTION 02505 – GRANULAR PAVING

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes crushed rock base and surface course.

1.02 SUBMITTALS

- A. Compliance submittals:
 - 1. Submit as specified in Division 1.
 - 2. Includes, but not limited to, the following:
 - a. Test results from testing laboratory indicating compliance with the specifications.
 - b. Certification of conformance with the specifications.

1.03 QUALITY ASSURANCE

- A. Applicable Standards:
 - 1. American Society for Testing and Materials (ASTM):
 - a. C117 - Material Finer than 76-um (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. C131 - Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - c. C136 - Sieve or Screen Analysis of Fine and Coarse Aggregates.
 - d. D423 - Liquid Limit of Soils.
 - e. D424 - Plastic Limit and Plasticity Index of Soils.
 - 2. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T99 - The Moisture Density Relations of Soils Using a 5.5-Pound (2.5 kg) Rammer and a 12-Inch (305 mm) Drop.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Crushed Rock base and surface course shall consist of aggregate specified.

2.02 AGGREGATE

- A. Aggregate shall be crushed stone or crushed gravel, free from lumps or balls of clay or other objectionable matter, and reasonably free from thin and elongated pieces of dirt. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality.
- B. Percentage of wear shall not exceed 50 after 500 revolutions as determined by ASTM C131.
- C. Aggregate shall contain 75 percent by weight of pieces with two or more fractured surfaces if material is crushed gravel.
- D. Portion of aggregate passing No. 40 sieve shall be as follows:
 - 1. Liquid Limit: Not more than 25 determined by ASTM D423.
 - 2. Plastic Index: Not more than 6 determined by ASTM D424.

- E. Gradation shall not vary from low limit on one sieve to high limit on adjacent sieve or vice versa. Test by ASTM C136 and C117, and conform to the following table:

Sieve Designation	Percent by Weight Passing Square-Mesh Sieve	
	Surface Course	Base Course
1-inch	100	100
1/2-inch	--	60-90
3/8-inch	65*	--
No. 4	--	40-60
No. 10	5-25	--
No. 40	--	15-35

*Indicates Maximum

2.03 EQUIPMENT

- A. General Requirements:
1. Maintain all equipment, tools, machines used in the performance of the work required by this Section in a satisfactory working condition at all times.
 2. Equipment shall be subject to the approval of the Engineer.
- B. Power Rollers:
1. Rollers shall be self-propelled, three wheel, or tandem-type with wheels equipped with adjustable scrapers.
 2. Weight shall not be less than eight tons.
- C. Tamping Rollers:
1. Rollers shall consist of one or more units arranged to adapt to uneven ground surfaces.
 2. Rolling units of multiple type shall be pivoted on the main frame.
 3. When fully loaded, rollers shall exert at least 300 psi on the combined areas of tamping feet in contact with the ground.
 4. Each unit shall be equipped with a watertight cylindrical drum with length 48 inches or greater.
 5. Tamping feet shall project not less than 7 inches from drum surface, with feet spaced not less than 10 inches, nor more than 10 inches measured diagonally from center to center.
- D. Rubber-Tired Rollers:
1. Rollers shall consist of two axles on which are mounted not less than nine pneumatic-tired wheels, mounted so the rear group of tires do not follow in the tracks of the forward wheels but will be centered between the forward wheels.
 2. The axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading.
 3. Inflate tires uniformly.
 4. May be self-propelled.
 5. Tow with pneumatic-tired tractors or other pneumatic-tired equipment.
- E. Blade Graders shall be self-propelled with a wheelbase of not less than 15 feet, and a blade of not less than 10 feet.
- F. Sprinkling equipment shall consist of tank trucks, pressure distributors, or other similar equipment designed to apply water uniformly and in controlled quantities to variable width of surface.

- G. Hauling equipment shall consist of pneumatic-tired vehicles and dump bodies suitable for dumping materials in windrows or layers on the subgrade.
- H. Tampers shall be mechanical (of an approved type) and hand-operated, weight not less than 50 pounds, and have a face area of not more than 100 square inches.
- I. Miscellaneous equipment shall consist of scarifiers, tractors, spring-tooth or spike-tooth harrows, windrow equalizers, spreaders, and other equipment suitable for construction of select material.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Stockpiles:
 - 1. Clear and level storage sites prior to stockpiling.
 - 2. Place in the manner and at locations designated by Engineer, providing separate stockpiles for materials from separate sources.
- B. Cold-Weather Limitations:
 - 1. Construction shall be prohibited when atmospheric temperature is below 35 degrees F.
 - 2. Do not place base course on frozen subgrade, or surface course on frozen base.
 - 3. Protect base course, surface course and subgrade in freezing weather and repair areas damaged by freezing by reshaping and recompacting.
- C. Preparation of Subgrade:
 - 1. Clear all vegetable matter such as trees, brush, down timber and other objectionable materials found on or above the surface.
 - 2. Scalp all excavation and embankment areas removing material such as sod, grass, residue or agricultural crops and decayed vegetable matter from the surface of the ground.
 - 3. Grub and dispose of all vegetable matter such as stumps, roots, buried trees and brush encountered below the surface of the ground or subgrade to a minimum depth of 6 inches.
 - 4. When deleterious materials are encountered below ground line which may be detrimental to the proposed improvement, these shall be removed to a depth necessary to provide adequate support for the proposed improvement.
 - 5. The subgrade surface shall be brought to the specified lines, grades and cross-section by repeatedly adding or removing material and compacting to the specified density.
 - 6. The top 6 inches of subgrade for pavements shall be compacted to 95 percent of the maximum density for the material used as determined by ASTM D-698 and within a tolerance of plus 2 percent and minus 3 percent of the optimum moisture at maximum density as determined by the moisture density curve obtained.
 - 7. The newly finished subgrade shall be repaired from action of the elements or others. Any settlement or erosion that occurs prior to placing the pavement thereon, shall be repaired and the specific lines, grades and cross-section reestablished.
 - 8. Any subgrade that has become unacceptable shall be reworked as necessary to restore the subgrade to shape, tolerance, density, and moisture content range for such density, immediately prior to the placing of the pavement.
- D. Grade Control: Establish and maintain by means of grade stakes placed in lanes parallel to the centerline of the area to be paved and spaced so string lines may be stretched between stakes.

3.02 MIXING AND PLACING OF MATERIALS

- A. Deposit and spread material in a uniform layer and compact to the thickness indicated on the plans and as specified below. Spread material uniformly on the prepared subgrade from moving vehicles or spreader boxes.
 - 1. Level material to the required contour and grades with blade graders.
 - 2. Remove those portions of the layer which become segregated in spreading and replace with satisfactory mixture or remix as requested by Engineer.
 - 3. Add water to the extent necessary to prevent segregation during mixing operations.
 - 4. Add material to the mixture in such amounts and sizes as requested by the Engineer.
- B. Shaping and Compacting Mixed Materials:
 - 1. Compact in layers no less than three nor more than seven inches thick.
 - 2. Roll to specified compaction requirements throughout full depth of layer with tamping rollers, power rollers, rubber-tired rollers or combination.
 - 3. Shape and smooth by blading and rolling with power roller or rubber-tired roller, or both.
 - 4. Hand-tamp in places not accessible to rolling equipment.
 - 5. Aerate by blade graders, harrows, or other approved equipment when mixture is moistened by rain.
- C. Degree of Compaction:
 - 1. Base compaction on weight per cubic foot of material passing 3/4-inch sieve and compact to at least 100 percent of density at optimum moisture.
 - 2. Determine and control compaction in accordance with AASHTO T99.
- D. Smoothness Test:
 - 1. Surface shall show no deviation in excess of 3/8-inch in any 10 feet when tested with a 10-foot straightedge applied parallel with and at right angles to the centerlines of the paved area.
 - 2. Correct any deviation in excess of this amount by loosening, adding or removing material, reshaping, watering, and compacting as requested by the Engineer.

3.03 MAINTENANCE

- A. Maintain finished base course in a condition satisfactory to the Engineer until job completion or until surface is placed upon it.

3.04 WAYBILLS AND DELIVERY TICKETS

- A. Submit daily to the Engineer during progress of work.

END OF SECTION

SECTION 02510 – WATER DISTRIBUTION

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes piping and specialties for water service.

1.02 SYSTEM PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressures: The following are minimum pressure requirements for piping and specialties, unless otherwise indicated:
 - 1. Water Service: 160 psig.

1.03 SUBMITTALS

- A. Product Data for the following:
 - 1. Water meters.
 - 2. Water-meter bars.
 - 3. Backflow preventers.
 - 4. Pipe and fittings.
 - 5. Flexible pipe fittings.
 - 6. Valves.
 - 7. Fire hydrants.
 - 8. Flushing hydrants.
 - 9. Yard hydrants.
- B. Shop Drawings: For precast concrete structures. Include frames and covers and drains.
- C. Record Drawings: At Project closeout of installed water-service piping according to Division 1.
- D. Test Reports: As specified in "Field Quality Control" Article in Part 3.
- E. Purging and Disinfecting Reports: As specified in "Cleaning and Disinfection" Article in Part 3.
- F. Maintenance Data: For specialties to include in the maintenance manuals specified in Division
 - 1. Include data for the following:
 - a. Water meters.
 - b. Backflow preventers.
 - c. Valves.
 - d. Fire hydrants.
 - e. Flushing hydrants.
 - f. Yard hydrants.

1.04 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-service piping specialties and are based on specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered.
- B. Comply with requirements of utility supplying water. Include tapping of water mains and backflow prevention.

- C. Comply with standards of authorities having jurisdiction for potable water-service piping. Include materials, installation, testing, and disinfection.
- D. Comply with NSF 61, "Drinking Water System Components--Health Effects," for materials for potable water.
- E. Comply with standards of authorities having jurisdiction for fire-protection water-service piping. Include materials, hose threads, installation, and testing.
- F. Provide listing/approval stamp, label, or other marking on piping and specialties made to specified standards.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors, unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.06 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Verify that water-service piping may be installed to comply with original design and referenced standards.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.

1.07 SEQUENCING AND SCHEDULING

- A. Coordinate connection to water main with utility company.
- B. Coordinate with other utility work.

1.08 CONTROLLING SPECIFICATION

- A. The more restrictive specification or requirement between the information shown in this document or the referenced Standard shall control.

PART 2 – PRODUCTS

2.01 PIPE MATERIAL

- A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.
- B. Copper Tube: ASTM B 88 (ASTM B 88M), seamless water tube, annealed temper.
- C. Ductile-Iron, Push-on-Joint Pipe: AWWA C151, with cement-mortar lining and seal coat according to AWWA C104. Include rubber compression gasket according to AWWA C111.
- D. Ductile-Iron, Mechanical-Joint Pipe: AWWA C151, with cement-mortar lining and seal coat according to AWWA C104. Include gland, rubber gasket, and bolts and nuts according to AWWA C111.
- E. PVC Plastic, Pipe: Class 200, DR 21. Include elastomeric seal according to ASTM F 477.

2.02 PIPE FITTINGS

- A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.
- B. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300, as required for system operating pressure.
- C. Ductile-Iron, Push-on-Joint Fittings: AWWA C110, ductile-iron; or AWWA C153, ductile-iron, compact type. Include cement-mortar lining and seal coat according to AWWA C104 and rubber compression gaskets according to AWWA C111.
- D. Ductile-Iron, Mechanical-Joint Fittings: AWWA C110, ductile-iron; or AWWA C153, ductile-iron, compact type. Include cement-mortar lining and seal coat according to AWWA C104 and glands, rubber gaskets, and bolts and nuts according to AWWA C111.
- E. Ductile-Iron, Flanged Fittings: AWWA C110, with cement-mortar lining and seal coat according to AWWA C104 or epoxy, interior coating according to AWWA C550. Include gaskets and bolts and nuts. Pipe flanges shall be ductile iron conforming to ANSI B16.1 and shall be drilled Class 125.
- F. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Units have 2 gasketed ball-joint sections and 1 or more gasketed sleeve sections. Include 250-psig (1725-kPa) minimum working-pressure rating; epoxy, interior coating according to AWWA C550; length for offset and expansion indicated; and glands, rubber gaskets, and bolts and nuts according to AWWA C111.
- G. Ductile-Iron, Deflection Fittings: Compound coupling fitting with sleeve and flexing sections, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include 250-psig minimum working-pressure rating; cement-mortar lining or epoxy, interior coating according to AWWA C550;

deflection of at least 20 degrees; and glands, rubber gaskets, and bolts and nuts according to AWWA C111.

- H. Ductile-Iron Expansion Joints: 3-piece assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include 250-psig minimum working-pressure rating; cement-mortar lining or epoxy, interior coating according to AWWA C550; length for expansion indicated; and glands, rubber gaskets, and bolts and nuts according to AWWA C111.
- I. Ductile-Iron Fittings for PVC Pipe: AWWA C110, ductile-iron or cast-iron; or AWWA C153, ductile-iron, compact type; push-on- or mechanical-joint type. Include dimensions matching PVC pipe, cement-mortar lining and seal coat according to AWWA C104, and rubber compression gaskets according to AWWA C111.

2.03 JOINING MATERIALS

- A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.
- B. Ductile-Iron Piping: The following materials apply:
 - 1. Push-on Joints: AWWA C111 rubber gaskets and lubricant.
 - 2. Mechanical Joints: AWWA C111 ductile-iron or gray-iron glands, high-strength steel bolts and nuts, and rubber gaskets.
 - 3. Flanged Joints: AWWA C115 ductile-iron or gray-iron pipe flanges, rubber gaskets, and high-strength steel bolts and nuts.
 - a. Gaskets: Rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
 - b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series.
- D. Pipe Couplings: Iron-body sleeve assembly, fabricated to match OD of pipes to be joined.
 - 1. Sleeve: ASTM A 126, Class B, gray iron.
 - 2. Followers: ASTM A 47 (ASTM A 47M), malleable iron; or ASTM A 536, ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.
- E. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.04 PIPING SPECIALTIES

- A. Flexible Connectors for Ferrous Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1 threaded steel pipe nipples or ASME B16.5 steel pipe flanges; welded to hose.
- B. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and corrosion.
 - 1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
 - 2. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.

3. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum pressure to suit system pressures.
4. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
5. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F.
6. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 deg F.

2.05 POLYETHYLENE PLASTIC ENCASEMENT

- A. Polyethylene Plastic Encasement for Ductile-Iron Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.06 VALVES

- A. Nonrising-Stem, Resilient-Seated Gate Valves, 3-Inch NPS (DN80) and Larger: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Include 200-psig minimum working-pressure design, interior coating according to AWWA C550, and buried valves shall be mechanical-joint with a 2-inch operating nut, exposed or interior valves shall have flanged ends and have hand wheel operators. Valves shall open counter clockwise. Valve stems shall use double "O" ring seals.
- B. Valve Boxes: For Traffic Areas - Cast-iron box with top section and cover with lettering "WATER," bottom section with base of size to fit over valve and barrel approximately 5 inches in diameter, and adjustable cast-iron extension of length required for depth of bury of valve.
 1. Provide steel tee-handle operating wrench. Include tee handle with one pointed end, stem of length to operate valve, and socket-fitting valve-operating nut.
- C. Valve Boxes: For Non-Traffic Areas - Cast-iron box with top section and cover with lettering "WATER," bottom section with base of size to fit over valve and barrel approximately 6 inches in diameter PVC and extend 4 inches above grade, and length required for depth of bury of valve.
- D. Curb Stops: Bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet to match service piping material.
- E. Tapping Sleeve and Tapping Valve: Complete assembly, including tapping sleeve, tapping valve, and bolts and nuts. Use sleeve and valve compatible with tapping machine.
 1. Tapping Sleeve: Cast- or ductile-iron, 2-piece bolted sleeve with flanged outlet for new branch connection. Sleeve may have mechanical-joint ends with rubber gaskets or sealing rings in sleeve body. Include sleeve matching size and type of pipe material being tapped and of outlet flange required for branch connection.
- F. Service Clamps and Corporation Stops: Complete assembly, including service clamp, corporation stop, and bolts and nuts. Include service clamp and stop compatible with drilling machine.
 1. Service Clamp: Cast iron or ductile iron with gasket and AWWA C800 threaded outlet for corporation stop, and threaded end straps.
 2. Corporation Stops: Bronze body and ground-key plug, with AWWA C800 threaded inlet and outlet matching service piping material.

- G. Ball Valves: AWWA C507, minimum operating pressure of 150 psig. Include interior coating according to AWWA C550, flanged valve ends. Bodies shall be ASTM 126, Class B cast iron for 2-1/2" and larger. Smaller valves shall be bronze body. Valve trim shall be bronze. Valves shall open counterclockwise. Exposed valves 3-inches and smaller shall be lever operated. Exposed valves 3-inches and larger shall be operated with a handwheel through an enclosed worm gear. Buried valves shall have a 2-inch operating nut operated by an enclosed worm gear operator.
- H. Butterfly Valves: AWWA C504, with 150-psig working-pressure rating. Include interior coating according to AWWA C550. Materials shall be: Body - Cast Iron ASTM A126, Class B; Shaft - Stainless Steel 18-8, Type 304; Disc - Iron for AWWA 150B service; and Seat - Buna-N rubber stainless steel trimmed. Valve shall be equipped with a suitable sized gear actuator and 2-inch operating nut. The body shall have mechanical joint ends. Retainer glands are to be used when installed on DIP.
- I. Check Valves: AWWA C508, with 175-psig working-pressure rating. Include interior coating according to AWWA C550. Valve hinge pins shall be stainless steel. Valve disc shall be full opening with a composition to metal seat. Valve shall be flanged unless noted otherwise on the Drawings. Valves shall be equipped with an external lever that is spring assisted. The spring tension shall be field adjustable by a hex nut. The lever arm shall be keyed to the valve hinge shaft.
- J. Check Valves - Cushioned: AWWA C508, with 175-psig working-pressure rating, with addition of exterior cushion chamber. Include interior coating according to AWWA C550. Swing disc type with stainless steel shaft and flanged body. Flanges shall be ANSI B16.1, Class 125. Valve disc shall have external lever and adjustable counterweight to initiate closure. Valves shall have a metal to composition seat.

2.07 SPECIALTY VALVES

- A. Pressure-Regulating Valves: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. Include 250-psig working-pressure design, bronze pressure-reducing pilot valve and tubing, and means for discharge pressure adjustment.
- B. Flow-Regulating Valves: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. Include 250-psig working-pressure design, bronze pressure-reducing pilot valve and tubing, and means for flow adjustment.
- C. Air-Release Valve: AWWA C512, hydromechanical device to automatically release accumulated air. Include 300-psig working-pressure design.
- D. Air/Vacuum Valve: AWWA C512, direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping. Include 300-psig working-pressure design.
- E. Combination Air Valves: AWWA C512, float-operated, hydromechanical device to automatically release accumulated air or to admit air. Include 300-psig working-pressure design.

2.08 WATER METERS

- A. Description: AWWA C700, displacement type, bronze main case. Register flow in gallons, unless cubic feet are indicated.
- B. Description: AWWA C702, compound type, bronze case. Register flow in gallons, unless cubic feet are indicated.

2.09 WATER-METER BOXES

- A. Description: The meter box covers shall be of cast iron construction of a good quality cast iron (at least 50 percent new pig) cover for disc-type water meter. Include lettering "WATER METER" in cover. It shall be constructed to fit on the meter box with lugs extended into the bottom to prevent displacement of the cover. Cover shall be Clay & Bailey, D2210 with lifting lugs or approved equal. The box cover shall be not less than 4-inches high. PVC plastic base slotted, open-bottom base section of length to fit over service piping.

2.10 CONCRETE PITS

- A. Description: Precast, reinforced-concrete pit, designed for A-16 load designation according to ASTM C 857, and made according to ASTM C 858.
- B. Ladder: ASTM A 36, steel or polyethylene-encased steel steps.
- C. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron, 24-inch minimum-diameter traffic frame and cover.
 - 1. Weight and Dimensions: Not smaller than 24-inch diameter, unless otherwise indicated.
- D. Drain: ASME A112.21.1M, cast-iron area drain, of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.11 FIRE HYDRANTS

- A. Description: AWWA C502 except as amended. Cast-iron body, compression-type valve, opening against pressure and closing with pressure, 6-inch (DN150) inlet with standard flange connection for directly bolting to auxiliary gate valve inlet, and 150-psig minimum working-pressure design. Hydrants shall have replaceable "breakable" sections.
- B. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
- C. Operating and Cap Nuts: Pentagon 1-1/2 inch point to flat.
- D. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
- E. Exterior Finish: Alkyd-gloss enamel paint, with color as designated by utility having jurisdiction.
- F. Dry-Barrel Fire Hydrants: AWWA C502, two 2-1/2-inch NPS (DN65) and one 4-1/2-inch NPS (DN115) outlets, 5-1/4-inch main valve, drain valve, and 6-inch NPS (DN150) mechanical-joint inlet. Include 250-psig minimum working-pressure design and interior coating according to AWWA C550.

2.12 FLUSHING HYDRANTS

- A. Description: Nonfreeze and drainable, with 150-psig minimum working-pressure rating and of length required for shutoff valve installation below frost line. Include one operating wrench for each unit.
- B. Post-Type Flushing Hydrants: With the following features:
 - 1. Outlet: One, with horizontal discharge.
 - 2. Hose Thread: 2-1/2-inch NPS (DN65), with NFPA 1963 external hose thread used by local fire department. Include cast-iron cap with brass chain.
 - 3. Barrel: Cast-iron or steel pipe with breakaway feature.
 - 4. Valve: Brass body with brass-ball or plunger closure, and automatic draining.

5. Security: Locking device for padlock.
 6. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
 7. Inlet: 2-inch NPS (DN50) minimum.
- C. Sampling Station: Post type with the following features:
1. Sampling Outlet: One unthreaded nozzle with handle.
 2. Valve: Brass body with brass-ball or plunger closure. Include operating handle.
 3. Drain: Tubing with separate manual vacuum pump.
 4. Inlet: 3/4-inch NPS (DN20) minimum.
 5. Housing: Weatherproof material with locking device. Include anchor device.

2.13 BACKFLOW PREVENTERS

- A. General: Manufactured backflow preventers, of size indicated for maximum flow rate and maximum pressure loss indicated.
- B. Working Pressure: 150 psig minimum, unless otherwise indicated.
- C. 2-Inch NPS (DN50) and Smaller: Bronze body with threaded ends.
- D. 2-1/2-Inch NPS (DN65) and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
- E. Interior Lining: AWWA C550, epoxy coating for backflow preventers with cast-iron or steel body.
- F. Interior Components: Corrosion-resistant materials.
- G. Strainer on inlet if strainer is indicated.
- H. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.
- I. Reduced-Pressure-Principle Backflow Preventer: AWWA C511, with OS gate valves on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves for continuous-pressure application.
1. Pressure Loss: 12 psig maximum through middle third of flow range.
- J. Double-Check-Valve Assembly: AWWA C510, with OS&Y gate valves on inlet and outlet, and strainer on inlet.
1. Pressure Loss: 5 psig maximum through middle third of flow range.
- K. Antisiphon, Pressure-Type Vacuum Breakers: ASSE 1020, with valves, spring-loaded check valve, and spring-loaded floating disc. Include test cocks and atmospheric vent for continuous-pressure application.
1. Pressure Loss: 5 psig maximum through middle third of flow range.

2.14 YARD HYDRANTS

- A. Yard Hydrants, Sanitary, Post Type: Nonfreeze, with nondraining chamber for storing water trapped downstream from inlet valve. Include 1-inch NPS (DN25) inlet, integral or field-installed vacuum breaker with outlet complying with ASME B1.20.7, 3/4-11.5NH threads for garden hose, brass or bronze casing, and other parts in contact with water, and are handle or key operated. Include body length required for installing storage chamber below frost line. Furnish 2 keys for each key-operated hydrant.

2.15 ANCHORAGES

- A. Clamps, Straps, and Washers: ASTM A 506, steel.
- B. Rods: ASTM A 575, steel.
- C. Rod Couplings: ASTM A 197, malleable iron.
- D. Bolts: ASTM A 307, steel.
- E. Cast-Iron Washers: ASTM A 126, gray iron.
- F. Concrete Reaction Backing: Portland cement concrete mix, 3000 psig.
 - 1. Cement: ASTM C 150, Type I.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.

2.16 IDENTIFICATION

- A. Arrange for detectable warning tapes made of solid blue film with metallic core and continuously printed black-letter caption "CAUTION--WATER LINE BURIED BELOW."

PART 3 – EXECUTION

3.01 EARTHWORK

- A. Refer to Division 2 Section "Earthwork" for excavation, trenching, and backfilling.

3.02 PIPING APPLICATIONS

Use pipe, fittings, and joining methods for piping systems according to the following applications:

- A. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- B. Do not use flanges for underground piping.
 - 1. Exception: Piping in boxes and structures, but not buried, may be joined with flanges instead of joints indicated.
- C. Flanges and special fittings may be used on aboveground piping.
- D. Water Piping: As indicated on the Drawings:
 - 1. 3/4- to 2-Inch NPS (DN20 to DN50): Copper tube, Type K (Type A); copper fittings; and brazed joints.
 - 2. 3/4- to 2-Inch NPS (DN20 to DN50): PVC plastic, Schedule 40 pipe push-on joint pipe; PVC plastic, Schedule 40, with push-on joints fittings.
 - 3. 4-Inch NPS (DN100 to DN200): Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.
 - 4. 4-Inch NPS (DN100 to DN200): Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 - 5. 4-Inch NPS (DN100 to DN200): PVC plastic, Class 200, ductile-iron fittings for PVC plastic pipe; and gasketed joints.
 - 6. 6- to 12-Inch NPS (DN150 to DN300): Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.

7. 6- to 12-Inch NPS (DN150 to DN300): Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
8. 6- to 12-Inch NPS (DN100 to DN200): PVC plastic, Class 200, ductile-iron fittings for PVC plastic pipe; and gasketed joints.

3.03 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used.

3.04 JOINT CONSTRUCTION

- A. Ductile-Iron Piping, Gasketed Joints: According to AWWA C600.
- B. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.
- C. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to fitting and valve ends into which pipes are being threaded.
- D. Copper Tubing, Brazed Joints: According to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
- E. PVC Piping, Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
- F. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, OD, and system working pressure. Refer to "Piping Systems - Common Requirements" Article below for joining piping of dissimilar metals.

3.05 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated.
- B. Install components with pressure rating equal to or greater than system operating pressure.
- C. Install piping free of sags and bends.
- D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- E. Install fittings for changes in direction and branch connections.
- F. Piping Connections: Unless otherwise indicated, make piping connections as specified below:
 1. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
 2. Install flanges, in piping 2-1/2-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 3. Install dielectric fittings to connect piping of dissimilar metals.
- G. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the quantities stipulated in Tables 4 & 5 of ANSI/AWWA C600 for ductile iron pipe and/or manufactures recommendations for other pipe material.

3.06 PIPING INSTALLATION

- A. Water-Main Connection: Tap water main with size and in location as indicated according to requirements of water utility.
- B. Make connections larger than 2-inch NPS (DN50) with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to manufacturer's written instructions.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Install gate valve onto tapping sleeve. Comply with AWWA C600. Install valve with stem pointing up and with cast-iron valve box.
 - 4. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
- C. Make connections, 2-inch NPS (DN50) and smaller, with drilling machine according to the following:
 - 1. Install service clamps and corporation stops in size, quantity, and arrangement required by utility company standards and according to manufacturer's written instructions.
 - 2. Install service clamps on pipe to be tapped. Position outlets for corporation stops.
 - 3. Install corporation stops into service clamps. Install with stem pointing up.
- D. Install ductile-iron piping according to AWWA C600.
- E. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- F. Install AWWA PVC plastic pipe according to AWWA M23 and ASTM F 645.
- G. Bury piping with depth of cover over top at least 42 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
 - 1. Under Driveways: With at least 42 inches cover over top.
 - 2. Under Railroad Tracks: With at least 48 inches cover over top.
 - 3. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.
- H. Install piping under streets and other obstructions that cannot be disturbed, by tunneling, jacking, or combination of both.

3.07 REACTION ANCHORAGE AND BLOCKING

- A. All unlugged bell and spigot or all-bell tees, Y-branches and bends deflecting 11-1/4 degrees or more which are installed in piping subjected to internal hydrostatic heads in excess of 15 feet in exposed, or 30 feet in buried, piping shall be provided with suitable reaction blocking, struts, anchors, clamps, joint harness, or other adequate means for preventing any movement of the pipe caused by unbalanced internal liquid pressure.
- B. Trench installation: Where in trench, the foregoing designated fittings shall be provided with concrete thrust blocking between the fitting and solid, undisturbed ground in each case, except where solid ground blocking support is not available. At the tops of slopes vertical angle bends shall be anchored by means of steel strap or rod anchors securely embedded in or attached to a mass of concrete of sufficient weight to resist the hydraulic thrust at the maximum pressures to which the pipe will be subjected. All concrete blocking and anchors shall be installed in such a manner that all joints between pipe and fittings are accessible for repair.
- C. The bearing area of concrete reaction blocking against the ground or trench bank shall be as shown by the plans or as directed by the Engineer in each case. In the event that adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods or bolts

- across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities approved by the Engineer shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to careless or otherwise improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.
- D. For other locations: Reaction blocking, struts, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the plans or as directed by the Engineer.
 - E. Protection of metal surfaces: All steel clamps, rods, bolts and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be adequately protected from corrosion with not less than two coats of Koppers "Bitumastic No. 50", or approved equal, heavy coal tar coating material, applied to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied. Metal surfaces exposed above grade or within structures shall be painted with two coats (in addition to a primer coat) of a paint approved by the Engineer.

3.08 LOCATION OF WATER MAINS WITH RESPECT TO SEWERS

- A. Horizontal Separation – water mains shall be laid at least ten feet (10') horizontally from any existing or proposed sewer line. The distance shall be measured edge-to-edge. In cases where it is not practical to maintain a ten foot (10') separation, the Missouri Department of Natural Resources may allow deviation on a case-by-case basis, if supported by data from the design engineer. This deviation may allow installation of the water main closer to a sewer, provided that the water line is in a separate trench or on an undisturbed earth shelf located on one (1) side of the sewer at an elevation that the bottom of the water line is at least eighteen inches (18") above the top of the sewer.
- B. Crossings – Water lines crossing sewers shall be laid to provide a minimum vertical distance of eighteen inches (18") between the outside of the water line and the outside of the sewer. This shall be the case where the water line is either above or below the sewer. The crossing shall be arranged so that the water line joints will be equidistant and as far as possible from the sewer joints. When a water line crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water line.
- C. Special Conditions – When it is impossible to obtain proper horizontal and vertical separation as stipulated previously, the sewer shall be designed and constructed of slip-on or mechanical joint ductile iron pipe or PVC pressure pipe for a distance of ten feet (10') on each side of the water line and shall be pressure tested to assure watertightness prior to backfilling.
- D. Sewer Manholes – No water pipe shall pass through or come into contact with any part of a sewer manhole.

3.09 VALVE INSTALLATION

- A. General Application: Use mechanical-joint-end valves for 3-inch NPS (DN80) and larger underground installation. Use flanged-end valves for installation in for exposed and interior valves. Use bronze corporation stops and valves, with ends compatible with piping, for 2-inch NPS (DN50) and smaller installation.
- B. AWWA-Type Gate Valves: Comply with AWWA C600. Install underground valves with stem pointing up and with cast-iron valve box.

- C. Bronze Corporation Stops and Curb Stops: Comply with manufacturer's written instructions. Install underground curb stops with head pointed up.

3.10 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
- C. Burial depths for hydrants may vary, but shall not be less than 4 feet. The steamer connection shall not be less than 12 inches nor greater than 24 inches above finished grade. The Contractor shall furnish and install all spool pieces as may be necessary to adjust hydrants to proper height.
- D. AWWA-Type Fire Hydrants: Comply with AWWA M17.

3.11 FLUSHING HYDRANT INSTALLATION

- A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb stop and restrained joints in supply piping.
- B. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb stop in supply piping.

3.12 WATER-METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written requirements.
- B. Water Meter: Install displacement-type water meters, 2-inch NPS (DN50) and smaller, in meter boxes with shutoff valve on water-meter inlet. Include valve on water-meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.
- C. Water Meter: Install compound-type water meters, 3-inch NPS (DN80) and larger, in meter pits. Include shutoff valves on water-meter inlet and outlet and valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

3.13 METER BOX CONSTRUCTION AND INSTALLATION

- A. Meter Box: Install PVC plastic, 18-inch diameter and not less than 36-inches in length.
- B. Meter Box Cover: The meter box covers shall be of cast iron construction of a good quality cast iron at least 50 percent of which shall be new pig. It shall be constructed to fit on the meter box with lugs extended into the bottom to prevent displacement of the cover. Cover shall be Clay & Bailey, D2210 with lifting lugs or approved equal. The box cover shall be not less than 4-inches high.

3.14 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to plumbing and health department authorities having jurisdiction.
- B. Do not install reduced-pressure-principle type in pit.
- C. Do not install bypass around backflow preventer.

- D. Support backflow preventers, valves, and piping on brick or concrete piers.

3.15 YARD HYDRANT INSTALLATION

- A. Install sanitary-type yard hydrants in pavement or with concrete anchor as indicated.

3.16 IDENTIFICATION INSTALLATION

- A. Install continuous plastic underground warning tape during back-filling of trench for underground water-service piping. Locate 6 to 8 inches below finished grade, directly over piping.

3.17 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Pressure Test:
- Test connections shall be made and the pipe filled with water. Unless otherwise specified, a pressure of 1.50 times the normal operating pressure (for the lowest point on the pipe line) but not less than the greater of 1.25 times the normal operating pressure or 150 pounds per square inch (psi). In no case shall the test pressure be allowed to exceed the design pressure for the pipe, appurtenances, or thrust restraints.
 - After air removal, water shall be pumped in to bring the pipe to the specified pressure. The hydrostatic test shall be of at least a 2-hour duration. Test pressure shall not vary by more than ± 5 psi for the duration of the test. After two hours, additional water shall be drawn from a container of known volume. The amount of water required to return the system to the specified pressure shall not exceed the amount determined by the following formula:

$$L = ND(P)^{1/2} / 7,400, \quad \text{(Equation 1, AWWA C605-94)}$$

Where

L - Allowable leakage, in gallons per hour
N - Number of joints in the length of pipeline tested
D - Nominal pipe diameter, inches
P - Average test pressure, psi (gauge)

The allowable leakage must not exceed the volumes specified below for 50 joints of the particular diameter of pipe being tested:

**Allowable Leakage per 50 joints of Pipe* - gph
(AWWA C-600)**

Avg. Test Pressure	Nominal Pipe Diameter (in)										
(psi)	1.5	2	3	4	6	8	10	12	14	16	18
300	0.18	0.23	0.35	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11
275	0.17	0.22	0.34	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02
250	0.16	0.21	0.32	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92
225	0.15	0.20	0.30	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82
200	0.14	0.19	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72
175	0.13	0.18	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61
150	0.12	0.17	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49

- All exposed pipe, fittings, valves, hydrants and joints shall be inspected and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the

Contractor by excavation where the pipe has been covered with backfill. Should the leakage test results exceed allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the Engineer to facilitate location of leaks.

4. All pipe, fittings, valves, pipe joints, hydrants, and other materials which are found to be defective when the pipe line is tested shall be removed from the line immediately and replaced with new and acceptable material by and at the expense of the Contractor. The pressure test shall be repeated after repairing leaks and other defective work until the pipe line installation conforms to specified requirements and is accepted by the Engineer.

C. Prepare reports for testing activities.

3.18 INTERRUPTED OPERATIONS

- A. When laying operations are interrupted or terminated at the end of a day, pipe ends shall be sealed temporarily to prevent the entry of water, debris, small animals, and similar types of contamination. Precautions shall be taken to prevent flotation of the sealed pipe during work stoppages.

3.19 CLEANING AND DISINFECTION

- A. Clean and disinfect water distribution piping as follows:
 1. Purge new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities, use procedure described in AWWA C651-99 or as described below:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine. Isolate system or part thereof and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. Following allowed standing time, flush system with clean, potable water until chlorine does not remain in water coming from system.
 3. Bacteriological Tests
 - a. Standard conditions. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 h apart, shall be collected from the new main. (Note: The pipe, the water loaded into the pipe, and any debris all exert a chlorine demand that can interfere with disinfection.) At least one set of samples shall be collected from every 1,200 ft of the new water main, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological (chemical and physical) quality in accordance with Standard Methods for the Examination of Water and Wastewater; and shall show the absence of coliform organisms; and, if required, the presence of a chlorine residual. Turbidity, pH, and a standard heterotrophic plate count or test may be required at the option of the purchaser, because new material does not typically contain coliforms but does typically contain HPC bacteria.
 - b. Special conditions. If trench water has entered the new main during construction or, if in the opinion of the purchaser, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 ft, and the location shall be identified. Samples shall be taken of water that has stood in the new main for at least 16 h after final flushing has been completed.
 - c. Sampling procedure. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by Standard Methods for the Examination of Water and Wastewater. No hose or fire hydrant shall be used in the collection of samples. (Note: For pipe repairs, if no other sampling port is available, well-flushed fire hydrants may be used with the understanding that they do not represent optimum sampling conditions.) There should be no water in the trench up to the connection for sampling. The sampling pipe must be dedicated and clean, and disinfected and flushed prior to sampling. A corporation

cock may be installed in the main with a copper-tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

- d. Record of compliance. The record of compliance shall be the bacteriological test results certifying that the water sampled from the new water main is free of coliform bacteria contamination and is equal to or better than the bacteriologic water quality in the distribution system.
- e. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained. High velocities in the existing system, resulting from flushing the new main, may disturb sediment that has accumulated in the existing mains. When check samples are taken, it is advisable to sample water entering the new main to determine the source of turbidity.

- B. Prepare reports for purging and disinfecting activities.

END OF SECTION

SECTION 02511 – HOT-MIX ASPHALT PAVING

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt patching.
 - 3. Hot-mix asphalt overlays.
 - 4. Asphalt surface treatments.
 - 5. Pavement-marking paint.
 - 6. Hot-mix asphalt curbs.
 - 7. Wheel stops.

1.02 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the standard specifications of the state or of authorities having jurisdiction.

1.03 SUBMITTALS

- A. Product Data: For each product specified. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Job-Mix Designs: For each job mix proposed for the Work.
- D. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate dedicated handicapped spaces with international graphics symbol.
- E. Samples: 12 by 12 inches minimum, of paving fabric.
- F. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and owners, and other information specified.
- G. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.
- H. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

- C. Testing Agency Qualifications: Demonstrate to Engineer's satisfaction, based on Engineer's evaluation of criteria conforming to ASTM D 3666, that the independent testing agency has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- D. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.
- E. Asphalt-Paving Publication: Comply with AI's "The Asphalt Handbook," except where more stringent requirements are indicated.
- F. Preinstallation Conference: Conduct conference at Project site to review methods and procedures related to asphalt paving including, but not limited to, the following:
 - 1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - 2. Review condition of substrate and preparatory work performed by other trades.
 - 3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - 4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute the Work without delays.
 - 5. Review inspection and testing requirements, governing regulations, and proposed installation procedures.
 - 6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location and within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:
 - 1. Prime and Tack Coats: Minimum surface temperature of 60 deg F (15.5 deg C).
 - 2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
 - 3. Asphalt Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.
 - 4. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.5 deg C) at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4 deg C) for oil-based materials, 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 – PRODUCTS

2.01 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.

- B. Coarse Aggregate: Sound; angular crushed stone; crushed gravel; or properly cured, crushed blast-furnace slag; complying with ASTM D 692.
- C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone; gravel, properly cured blast-furnace slag, or combinations thereof; complying with ASTM D 1073.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
- D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.

2.02 ASPHALT MATERIALS

- A. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.
- B. Asphalt Cement: ASTM D 3381 for viscosity-graded material.
- C. Undersealing Asphalt: ASTM D 3141, pumping consistency.
- D. Prime Coat: ASTM D 2027; medium-curing cutback asphalt; MC-30, MC-70, or MC-250.
- E. Prime Coat: Asphalt emulsion prime coat material shall conform to Missouri Standard Specifications for Highway Construction, Section 408.
- F. Tack Coat: Asphalt emulsion tack coat material shall conform to Missouri Standard Specifications for Highway Construction, Section 409.
- G. Fog Seal: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- H. Water: Potable.

2.03 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- C. Paving Geotextile: Nonwoven polypropylene, specifically designed for paving applications, resistant to chemical attack, rot, and mildew.
- D. Pavement-Marking Paint: Alkyd-resin type, ready-mixed, complying with FS TT-P-115, Type I, or AASHTO M-248, Type N.
- E. Pavement-Marking Paint: Latex, water-base emulsion, ready-mixed, complying with FS TT-P-1952.
- F. Glass Beads: AASHTO M-247.
- G. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, approximately 6 inches high, 9 inches wide, and 84 inches long. Provide chamfered corners and drainage slots on underside, and provide holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, diameter 3/4 inch, minimum length 10 inches.

2.04 MIXES

- A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI's "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: As indicated.
 - 3. Surface Course: As indicated.
- B. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI's "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Provide mixes complying with the composition, grading, and tolerance requirements of ASTM D 3515 for the following nominal, maximum aggregate sizes:
 - a. Base Course: 1 inch.
 - b. Surface Course: 1/2 inch.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Notify Engineer in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.02 COLD MILLING

- A. Clean existing paving surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement, including hot-mix asphalt and, as necessary, unbound-aggregate base course, by cold milling to grades and cross sections indicated.
 - 1. Repair or replace curbs, manholes, and other construction damaged during cold milling.

3.03 PATCHING AND REPAIRS

- A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.
 - 1. Tack coat faces of excavation and allow to cure before paving.
 - 2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
 - 3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
 2. Remove disintegrated or badly broken pavement. Prepare and patch with hot-mix asphalt.
- C. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 1/4 inch. Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.
- E. Tack Coat: Apply uniformly to existing surfaces of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. of surface.
1. Allow tack coat to cure undisturbed before paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.04 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.
- C. Prime Coat: Apply uniformly over surface of compacted-aggregate base at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 72 hours minimum.
1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use just enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 2. Protect primed substrate from damage until ready to receive paving.

3.05 GEOTEXTILE INSTALLATION

- A. Apply bond coat, consisting of asphalt cement, uniformly to existing surfaces at a rate of 0.20 to 0.30 gal./sq. yd.
- B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.
1. Protect paving geotextile from traffic and other damage and place overlay paving the same day.

3.06 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 2. Place hot-mix asphalt surface course in single lift.
 3. Spread mix at minimum temperature of 250 deg F.
 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide, except where infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.07 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat.
 2. Offset longitudinal joints in successive courses a minimum of 6 inches.
 3. Offset transverse joints in successive courses a minimum of 24 inches.
 4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."
 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.08 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Average Density: 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent.
 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.

- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.09 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat, unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F.
 - 1. Asphalt Mix: Same as pavement surface-course mix.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.11 SURFACE TREATMENTS

- A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. Lightly dust areas receiving excess fog seal with a fine sand.
- B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
 - 1. Roll slurry seal to smooth ridges and provide a uniform, smooth surface.

3.12 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- B. Allow paving to cure for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal.

3.13 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than 2 galvanized steel dowels embedded in precast concrete at one-third points. Firmly bond each dowel to wheel stop and to pavement.
 1. Extend upper portion of dowel 5 inches into wheel stop and lower portion a minimum of 5 inches into pavement.

3.14 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports.
 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.
- B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.
 1. Reference laboratory density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 1559, and compacted according to job-mix specifications.
 2. Reference maximum theoretical density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 3. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, but in no case will fewer than 3 cores be taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

SECTION 02520 – PORTLAND CEMENT CONCRETE PAVING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of portland cement concrete paving is shown on drawings, including curbs, gutters, walkways and pavement.
- B. Prepared subbase is specified in "Earthwork" section.
- C. Concrete and related materials are specified in Division 3.
- D. Joint fillers and sealers are specified in Division 7.

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Comply with local governing regulations if more stringent than herein specified.

1.04 SUBMITTALS

- A. Furnish samples, manufacturer's product data, test reports, and materials' certifications as required in referenced sections for concrete and joint fillers and sealers.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
 - 1. Use flexible spring steel forms or laminated boards to form radius bends as required.
 - 2. Coat with a non-staining form release agent that will not discolor or deface surface of concrete.
- B. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 40 or Grade 60.
- C. Fabricated Bar Mats: Welded or clip-assembled steel bar or rod mats, ASTM A 184. Use ASTM A 615, Grade 40 steel bars, unless otherwise indicated.
- D. Concrete Materials: Comply with requirements of applicable Division 3 sections for concrete materials, admixtures, bonding materials, curing materials, and other required materials.
- E. Expansion Joint Materials: Comply with requirements of applicable Division 7 sections for preformed expansion joint fillers and sealers.
- F. Liquid Membrane Forming Curing Compound: Complying with ASTM C 309, Type I, Class A unless other type acceptable to Engineer. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to the following:
 - a. "Masterseal"; Master Builders.
 - b. "J-20 Acrylic Cure"; Dayton Superior.
 - c. "Kure-N-Seal"; Sonneborn-Contech.
 - d. "L&M Cure"; L & M Construction Chemicals.
 - e. "LR-152"; Protex Industries.
 - f. or approved equal.
- G. Bonding Compound: Polyvinyl acetate or acrylic base, rewettable type.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "J-40 Bonding Agent"; Dayton Superior Corp.
 - b. "Weldcrete"; Larsen Products.
 - c. "Everbond"; L & M Construction Chemicals.
 - d. "EucoWeld"; Euclid Chemical Co.
 - e. "Hornweld"; A. C. Horn.
 - f. "Sonocrete", Sonneborn-Contech.
 - g. "Acrylic Bondcrete"; The Burke Co.
 - h. or approved equal.
- H. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.
 1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 - a. "Epoxite", A. C. Horn.
 - b. "Edoco 2118 Epoxy Adhesive"; Edoco Technical Prod.
 - c. "Sikadur Hi-Mod"; Sika Chemical Corp.
 - d. "Euco Epoxy 463 or 615"; Euclid Chemical Co.
 - e. "Patch and Bond Epoxy"; The Burke Co.
 - f. "Sure-Poxy"; Kaufman Products Inc.
 - g. or approved equal.

2.02 CONCRETE MIX, DESIGN AND TESTING

- A. Comply with requirements of applicable Division 3 sections for concrete mix design, sampling and testing, and quality control.

PART 3 – EXECUTION

3.01 SURFACE PREPARATION

- A. Remove loose material from compacted subbase surfaces immediately before placing concrete.
- B. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.02 FORM CONSTRUCTION

- A. Set forms to required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
- B. Check completed form work for grade and alignment to following tolerances:
 1. Top of forms not more than 1/8" in 10'.
 2. Vertical face on longitudinal axis, not more than 1/4" in 10'.

- C. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

3.03 REINFORCEMENT

- A. Locate, place and support reinforcement as specified in Division 3 sections, unless otherwise indicated.

3.04 CONCRETE PLACEMENT

- A. General: Comply with requirements of Division 3 sections for mixing and placing concrete, and as herein specified.
- B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- C. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
 - 1. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 2. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place a construction joint.
 - 3. When adjacent pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained sufficient strength to carry loads without injury.
- D. Fabricated Bar Mats: Keep mats clean and free from excessive rust, and handle units to keep them flat and free of distortions. Straighten bends, kinks, or other irregularities or replace units as required before placement. Set mats for a minimum 2" overlap to adjacent maps.
- E. Place concrete in 2 operations; strike-off initial pour for entire width of placement and to the required depth below finish surface. Lay fabricated bar mats immediately in final position. Place top layer of concrete, strike-off and screed.
 - 1. Remove and replace portions of bottom layer of concrete which has been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Engineer.
- F. Curbs and Gutters: Automatic machine may be used for curb and gutter placement at Contractor's option. If machine placement is to be used, submit revised mix design and laboratory test results which meet or exceed minimums specified. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.05 JOINTS

- A. General: Construct expansion, weakened-plane (contraction), and construction joints true-to-line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.
 - 1. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.

- B. Weakened Plane (Contraction) Joints: Provide weakened-plane (contraction) joints, sectioning concrete into areas as shown on drawings. Construct weakened-plane joints for a depth equal to at least 1/4 concrete thickness as follows:
 - 1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.
 - 2. Sawed Joints: Form weakened-plane joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.
 - 3. Inserts: Use embedded strips of metal or sealed wood to form weakened-plane joints. Set strips into plastic concrete and carefully remove strips after concrete has hardened.
- C. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for a period of more than 1/2 hour, except where such placements terminate at expansion joints.
 - 1. Construct joints as shown or, if not shown, use standard metal keyway-section forms.
- D. Expansion Joints: Provide premolded joint filler for expansion joints, putting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.
 - 1. Extend joint fillers full width and depth of joint, and not less than 1/2" or more than 1" below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surfaces.
 - 2. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.
 - 3. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.
- E. Fillers and Sealants: Comply with requirements of applicable Division 7 sections for preparation of joints, materials, installation, and performance.

3.06 CONCRETE FINISHING

- A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.
- B. After floating, test surface for trueness with a 10' straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish.
- C. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate tool marks on concrete surface.
- D. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
 - 1. Broom finish, by drawing a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Engineer.
- E. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Engineer.

3.07 CURING

- A. Protect and cure finished concrete paving, complying with applicable requirements of Division 3 sections. Use membrane-forming curing and sealing compound or approved moist-curing methods.

3.08 REPAIRS AND PROTECTIONS

- A. Repair or replace broken or defective concrete, as directed by Engineer.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement unless specified otherwise. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Sweep concrete pavement and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.

END OF SECTION

SECTION 02530 – SANITARY SEWERAGE

PART 1 – GENERAL

1.01 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene-monomer rubber.
- B. NPS: Nominal pipe size.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.02 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.
- B. Force-Main Pressure Ratings: At least equal to system operating pressure, but not less than 150 psig (1035 kPa).

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Valves and cleanouts.
 - 2. Manhole cover inserts.
 - 3. Pipe and fittings.
 - 4. Manhole Repair Materials
- B. Shop Drawings: Include plans, elevations, details, and attachments for precast concrete manholes, including frames and covers.
- C. Record Drawings: At Project closeout of installed sanitary sewerage all record drawings shall be submitted to the Owner. The record drawings shall accurately record actual locations of pipe runs, connections, cleanouts, manhole top and invert elevations, air-relief valves and lift station data. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.
- D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves according to the following:
 - 1. Do not remove end protectors, unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

- C. Handling: Use sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support piping to prevent sagging and bending.
- H. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.05 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated. Notify property owner not less than two days in advance of proposed utility interruptions.

PART 2 – PRODUCTS

2.01 PIPING MATERIALS

- A. Refer to Part 3 “Piping Applications” Article for applications of pipe and fitting materials.

2.02 PIPES AND FITTINGS

- A. Ductile-Iron Pressure Pipe: AWWA C150 and C151 except as otherwise specified.
 - 1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, buried or flooded pipe shall have mechanical joints, interior or exposed pipe shall have flanges unless otherwise indicated or specified. No 90 degree bends are allowed.
 - 2. Gaskets: AWWA C111, Rubber
 - 3. Flanges: Ductile iron, conforming to ANSI B16.1 and shall be drilled class 125.
 - 4. Flange Bolts: Bolts shall conform to ASTM A307 Grade B. All exposed bolts shall be Type 304 stainless steel.
 - 5. Flange Gaskets: Shall be 1/8" thick, full-faced synthetic rubber.
 - 6. Lining: All ductile iron pressure piping and fittings shall be lined with 401 Protecto lining conforming to ASTM E-96, ASTM G-95, ASTM B-117, ASTM G-14, ASTM D-714, ASTM D-1308, or equal, unless otherwise indicated. Lining shall extend from end of flange to end of flange. The lining shall not be used on the face of the flange. Lining to be applied in accordance with the specifications in the “Protecto 401 Ceramic Epoxy Standard for Lining Ductile Iron Pipe and Fittings for Sewer Service” 2017 Edition.
- B. Ductile-Iron Gravity Sewer Pipe: ASTM A 746, for push-on joints.
 - 1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.

2. Gaskets: AWWA C111, rubber.
 3. Lining: All ductile iron gravity piping and fittings shall be lined with 401 Protecto lining conforming to ASTM E-96, ASTM G-95, ASTM B-117, ASTM G-14, ASTM D-714, ASTM D-1308, or equal, unless otherwise indicated. Lining shall extend from edge of plain end to the gasket seat in the bell socket. Lining to be applied in accordance with the specifications in the "Protecto 401 Ceramic Epoxy Standard for Lining Ductile Iron Pipe and Fittings for Sewer Service" 2017 Edition.
 4. Polyethylene Plastic (PE) Film, Pipe Encasement: All buried ductile iron piping and fittings shall be encased in polyethylene as per Section 2.05.
- C. PVC Pressure Pipe: AWWA C900, Class 200 or ASTM 2241, 200 psi, SDR 21, for gasketed joints.
1. Ductile-Iron, Compact Fittings: AWWA C153, for push-on joints. All ductile iron fittings shall be lined with 401 Protecto lining conforming to ASTM E-96, ASTM G-95, ASTM B-117, ASTM G-14, ASTM D-714 ASTM D-1308 or equal, unless otherwise indicated. No 90 degree bends are allowed.
 2. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.
 3. Joint Restraints for PVC Pipe: Megalug or approved equal, AWWAC600, ASTM D 2774, ASTM F 1674.
- D. PVC Gravity Sewer Pipe and Fittings: According to the following:
1. PVC Sewer Pipe and Fittings, NPS 15 and Smaller:
 - a. Less than 12 feet of cover: ASTM D 3034, SDR 35, bell and spigot for gasketed joints. Gaskets are to conform to ASTM F 477, elastomeric seals.
 - b. 12 feet to 20 feet of cover: SDR 21, Class 200, bell and spigot for gasketed joints. Gaskets are to conform to ASTM F 477, elastomeric seals.
 - c. Over 20 feet of cover: Pipe material and classification for PVC sewer pipe 20 feet or greater in depth will be considered on a case by case basis by the Owner.
 2. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints. Gaskets are to conform to ASTM F 477, elastomeric seals.
 3. PVC Sewer Lateral Pipe and Fittings, NPS 4 to 6: ASTM D2665 and ASTM D1785, Schedule 40, solvent-cemented joints, or gaskets and gasketed joints.
- E. Polyethylene Pressure Pipe and Fittings
1. Polyethylene Pipe (4 inch and larger):
 - a. Polyethylene pipe shall be made from HDPE material having a material designation code of PE3608 or higher. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE345464C. In addition, the material shall be listed as meeting NSF-61.
 - b. The pipe and fittings shall meet the requirements of AWWA C906.
 - c. HDPE pipe shall be rated for use at a pressure class of 200 psi, DR-9. The outside diameter of the pipe shall be based upon the IPS or DIPS sizing system.
 - d. The pipe shall be marked in accordance with the standards to which it is manufactured.
 - e. Color identification by the use of stripes on pipe to identify pipe service shall be required. Stripes or colored exterior pipe product shall be blue for potable water, green for wastewater/sewage, purple for reclaimed water, or black for raw water.
 - f. Pipe manufacturer shall be listed in Manufacturer list in PPI TR-4.
 - g. Pipe shall be gray in color.
 2. Polyethylene Fittings:
 - a. Butt Fusion Fittings
Fittings shall be made of HDPE material with a minimum material designation code of PE3608 and with a minimum Cell Classification as noted in 2.01A. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All fittings shall meet the requirements of AWWA C906. Markings for molded fittings shall comply with the requirements of ASTM D 3261. Fabricated fittings shall be marked in accordance with ASTM F 2206. Socket fittings shall meet ASTM D 2683.

- b. Electrofusion Fittings
Fittings shall be made of HDPE material with a minimum material designation code of PE 3608 and with a minimum Cell Classification as noted in 2.01A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting. Markings shall be according to ASTM F 1055.
- c. Flanges and Mechanical Joint Adapters (MJ Adapters)
Flanges and Mechanical Joint Adapters shall have a material designation code of PE3608 or higher and a minimum Cell Classification as noted in 2.01A. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261. Fabricated (including machined) flange adapters shall be per ASTM F 2206.
- d. Van-Stone style, metallic (including stainless steel), convoluted or flat-plate, back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note # 38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125, or AWWA C207 Class 150 Series B, D, or E. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressure-class of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The back-up ring, bolts, and nuts shall be protected from corrosion by a system such as paint, coal-tar epoxy, galvanization, polyether or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by the project engineer.
- e. Service connections
Service connections shall be electrofusion saddles with a brass or stainless steel threaded outlet, electrofusion saddles, sidewall fusion branch saddles, tapping tees, or mechanical saddles.
 - i. Electrofusion Saddles
Electrofusion Saddles with threaded outlet the size of the outlet shall be one inch IPS unless a larger size is shown on the plans. Electrofusion saddles shall be made from materials required under Electrofusion Fittings.
 - ii. Sidewall Fusion Saddles
For sidewall fusion saddles the size of the saddle shall be as indicated on the plans. The saddle shall be made in accordance to ASTM D 3261 or ASTM F 2206. After installation, approximately $\frac{1}{4}$ " of the PE pipe shall be visible beyond the saddle to confirm that proper surface preparation occurred. Saddle faces that do not provided $\frac{1}{4}$ inch of area beyond the saddle are not acceptable.
 - iii. Tapping Tees
 - iv. Tapping tees shall be made to ASTM D3261 or D2683.
 - v. Mechanical Strap-On Saddles
Mechanical strap-on saddles shall only be used where this use on PE pipe is approved by the mechanical saddle manufacturer. The body of the saddle shall be stainless steel, epoxy coated cast iron or brass. The gasket material and design must be acceptable for PE pipe. The outlet shall be threaded for one inch IPS unless a larger size is shown on the plans. Mechanical strap-on saddles will be installed per the manufacturer's instructions.
- f. Fitting manufacturer shall be listed in Manufacturer list in PPI TR-4

2.03 SPECIAL PIPE COUPLINGS AND FITTINGS

- A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
 - 1. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.

2. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 3. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
 4. Bands: Stainless steel, at least one at each pipe insert.
- B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.
1. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 2. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 3. Material for Dissimilar Pipe: Compatible with pipe materials being joined.
- C. Pressure-Type Pipe Couplings: AWWA C219, iron-body sleeve assembly matching OD of pipes to be joined, with AWWA C111 rubber gaskets, bolts, and nuts. Include PE film, pipe encasement.
- D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated. Include PE film, pipe encasement.
- E. Ductile-Iron Deflection Fittings: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees deflection. Include PE film, pipe encasement.
- F. Ductile-Iron Expansion Joints: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated. Include PE film, pipe encasement.

2.04 VALVES AND ACCESSORIES

- A. Nonrising-Stem, Resilient-Seated Gate Valves, 2-1/2 Inch NPS and Larger: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Include 200-psig minimum working-pressure design, interior coating according to AWWA C550, and buried valves shall be mechanical-joint with a 2-inch operating nut, exposed or interior valves shall have flanged ends and have hand wheel operators. Valves shall open counter clockwise. Valve stems shall use double "O" ring seals. Bolts shall be stainless steel. Exterior surface of valve shall have corrosion inhibitor coating.
- B. Check Valves, 2-1/2 Inch NPS and Larger: (to be used only when plans specify that swing check valve is not required) AWWA C508, with 175-psig working-pressure rating. Include interior coating according to AWWA C550. Exterior surface of valve shall have corrosion inhibitor coating. Valve hinge pins shall be stainless steel. Valve disc shall be full opening with a composition to metal seat. The composition material shall be suitable for use in domestic water and wastewater service. Valve shall be flanged unless noted otherwise on the Drawings. Valves shall be equipped with an external lever that is spring assisted. The spring tension shall be field adjustable by a hex nut. The lever arm shall be keyed to the valve hinge shaft.
- C. Check Valves: AWWA C508, with 250-psig working pressure rating. Valmatic Surgebuster Swing Check Valve or approved equal. Check valve shall be of the full body type, with a domed access cover and only two moving parts, the flexible disc and the disc accelerator. Flanges shall be ANSI B16.1, Class 125. The disc shall be molded Buna-N, ASTM D2000-BG. The disc shall be of one-piece construction with an integral o-ring type sealing surface and contain alloy steel and nylon reinforcement in the flexible hinge area. The disc accelerator shall be Type 302 stainless steel. The disc accelerator shall be of one piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve

from the line. The disc accelerator shall be securely held in place captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface. Provide mechanical indicator on all size valves. The mechanical indicator shall be a lever type, with no plunger action and no hard connection to the back of the disc required. Provide backflow actuator on all size valves. A screw-type backflow actuator shall be provided (when specified) to allow opening of the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a Lead-Free bronze bushing. The backflow device shall be of the rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation. Interior and exterior surface of valve shall have Fusion Bonded Epoxy corrosion inhibitor coating.

D. Eccentric Plug Valves:

1. Plug valves shall be quarter-turn non-lubricated eccentric type with resilient faced plug. Include interior coating according to AWWA C550. Alternate seat and plug materials may be considered provided this specification is met and, in addition, the manufacturer must prove prior to approval that the valve meets AWWA C504 "proof of design tests" (10,000 cycles) in both directions. Flanged valve ends shall be faced and drilled to conform to ANSI B16.1, Class 150 for diameter and drilling. Include interior coating according to AWWA C500. Mechanical or push-on type rubber-gasketed joint ends shall conform to AWWA C111. Port areas for valves smaller than 20-inch shall be at least 80 percent of full pipe area. Port areas for valves 24-inch and larger shall be at least 70 percent of full pipe area.
2. Materials and Construction:
 - a. Bodies shall be of ASTM A126, Class B cast iron. Exterior surface of valve shall have corrosion inhibitor coating.
 - b. Valve plug shall be ASTM A126, Class B cast iron or ASTM A536 ductile iron. Resilient plug facing shall be synthetic rubber, neoprene or Buna N compound suitable for use with water and wastewater applications.
 - c. Seats shall be a raised welded overlay of 90% pure nickel, a minimum of .125" thick and 0.50" wide, conforming to AWWA C504. When the plug is in the closed position, the resilient plug facing shall contact only nickel. Sprayed or plated mating seat surfaces are not acceptable for resilient plugs.
 - d. Bearings shall be replaceable. Sleeve bearings in the upper and lower journals shall be permanently lubricated 316 stainless steel per ASTM A743 Grade CF-8M. Nonmetallic journal bearings shall not be acceptable. Thrust bearings shall be Teflon.
 - e. Shaft seals shall be self-adjusting chevron-type conforming to AWWA C504. Valve shall be designed so it can be repacked while the valve is in line and under pressure without removing the actuator. O-ring seals shall not be acceptable in valves larger than 3".
 - f. All exposed fastening hardware shall be zinc plated or stainless steel. Provide stainless steel bolting on buried service valves.
3. Manual Operators:
 - a. All valves shall open counterclockwise.
 - b. Provide indicators to show position of plug except on buried operators.
 - c. Actuators: Manual valves shall have lever or worm gear actuators with handwheels, chainwheels, tee wrenches, extension stems, floorstands, etc., as shown on the plans or as called for in the valve schedule. Lever actuators shall be furnished for valves 8" or smaller where the maximum shutoff pressure is 25 psi or less as indicated on the plans or in the valve schedule. Worm gear actuators shall be furnished for all valves 4" or larger where the maximum reverse shutoff pressure is greater than 25 psi. Worm gear actuators shall be sized for 150 psi. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. This adjustable stop shall be the only adjustment necessary to set the clearance between the valve plug and the seat while the valve is in line and under pressure. Handwheel and chainwheel sizes for worm gear actuators shall be no smaller than

6" in diameter and no larger than twice the diameter of the actuator's gear sector. All exposed nuts, bolts, and washers shall be zinc plated. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs, and washers shall be stainless steel.

- d. Exposed or interior valves shall be operated by a hand wheel to be supplied with the valve.
- e. Buried valves shall be operated by a 2" square AWWA nut.
- 4. Testing: Furnish certified copies of results of tests prior to shipment. All valves shall be subjected to an AWWA C504 procedure leak test at 150 psi against the face of the plug and a body hydrostatic test at 300 psi. Valves shall be capable of providing drip-tight shutoff up to the full leak test rating with pressure in either direction.
- 5. Electric Motor Operator for Eccentric Plug Valves:
 - a. As manufactured by AUMA or approved equal.
 - b. SQ part turn actuator with mechanical end stops
 - c. Handwheel extension for emergency operation
 - d. AM Integral Controls – Open, Stop, Close
 - e. Flange and Output Shaft
 - i. Coupling unbored
 - f. Plug/Socket Connector
 - g. Electromechanical Control Unit
 - i. Limit/Torque Switch – Single Switch
 - ii. Handwheel Activation
 - iii. Vibration Resistance: Actuators withstand vibration during start-up or in case of plant failures up to 1g, within the frequency range from 10 to 200 Hz
 - iv. Mount Position: Can be operated without restriction in any mounting position
 - v. Noise Level: Noise level originated by the actuator shall remain below the noise level of 72 dB (A).
 - h. Supply Voltage: 480 VAC
 - i. Nema 4x/6 with Local Controls
- E. Ball Valves
 - 1. Ball valves shall be standard port type with 3-piece body. Flanged valve ends shall be faced and drilled to conform to ANSI B16.1, Class 50 for thickness and drilling. Mechanical or push-on type rubber-gasketed joint ends shall conform to AWWA C111.
 - 2. Materials and Construction:
 - a. Ball valves 6" and larger shall conform to AWWA C507 with a minimum design operating pressure of 150 psig.
 - b. Bodies shall be of ASTM 126, Class B cast iron for 2-1/2" and larger. Smaller valves shall be bronze body.
 - c. Valve trim shall be bronze.
 - 3. Manual Operators:
 - a. All valves shall open counterclockwise.
 - b. Exposed valves 3" and smaller shall be lever operated.
 - c. Provide indicators to show position of ball.
 - d. AWWA 2" size nut operators operated by enclosed worm gear operators shall be provided for buried valves.
 - e. Exposed valves over 3" diameter shall have AWWA 2" square operation by enclosed worm gear operators.
- F. Ball Valves (Polymer Service and Non-Potable Water 2" And Smaller)
 - 1. Ball valves shall be PVC true union with either solvent socket or threaded pipe connections. Pressure rating shall exceed 230 psi.
 - 2. Seats shall be PTFE with backing rings. Backing rings and seals shall be EPDM.

3. PVC shall meet or exceed cell classification 12454B, ASTM D-1784.
 4. Socket end connections shall conform to ASTM D-2467. Threaded pipe connections shall conform to ANSI B2.1.
 5. Exposed valves shall be operated by a 2" AWWA nut. Valve shall not be buried.
- G. Backwater Valves
1. Gray-Iron Backwater Valves: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
 - a. Horizontal Type: With swing check valve and hub-and-spigot ends.
 - b. Combination Horizontal and Manual Gate-Valve Type: With swing check valve, integral gate valve, and hub-and-spigot ends.
 - c. Terminal Type: With bronze seat, swing check valve, and hub inlet.
 2. PVC Backwater Valves: Similar to ASME A112.14.1, horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
- H. Air Release/Vacuum Valves:
1. Air release/vacuum valves shall be A.R.I. model D-025 combination air valve for sewage or approved equal.
 2. Valve shall be heavy-duty combination air release/vacuum, sewage style.
 3. Body shall be made of stainless steel or reinforced nylon.
 4. Float shall be stainless steel.
 5. All internal parts shall be stainless steel or non-metallic poly materials.
- I. Appurtenances:
1. Valve Boxes shall be slide-type, cast iron, adjustable with the word "SEWER" on the lid.
 2. Trace Wire: See Section 02537 for Tracer Wire Specification. Tracer required on all gravity mains, force mains, and service laterals.

2.05 POLYETHYLENE PLASTIC (PE) FILM, PIPE ENCASEMENT

- A. Buried gravity ductile iron piping and fittings shall be encased with a polyethylene plastic coating conforming to ASTM A 674 or AWWA C105; PE film, tube, or sheet; 8-mil thickness.

2.06 MANHOLES

- A. Normal-Traffic Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
1. Diameter: 48 inches minimum, unless otherwise indicated.
 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 3. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having base section with integral floor.
 4. Riser Sections: 5-inch minimum thickness and lengths to provide depth indicated.
 5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 6. Gaskets: ASTM C 443 rubber.
 7. Grade Rings: No more than three reinforced-concrete rings shall be used on any manhole. Combined ring height shall not be less than 4" or exceed 12". The minimum ring thickness is 4". Grade rings shall match 24-inch diameter frame and cover.
 8. Steps: Per ASTM C478, plastic steps, individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals.
 9. Pipe Connectors: ASTM C 923 resilient, of size required, for each pipe connecting to base section. A-LOK manhole pipe connector or equal.

- a. When connecting into an existing manhole, the manhole shall be cored drilled to allow new pipe to enter. Cutting or chipping the opening is not permitted. A rubber gasket and non-shrink grout shall be used to provide a tight seal around pipe.
- B. Heavy-Traffic Precast Concrete Manholes: ASTM C 913; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for rubber gasketed joints.
 1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to structure, as required to prevent flotation.
 2. Gaskets: ASTM C 443 rubber.
 3. Grade Rings: No more than three reinforced-concrete rings shall be used on any manhole. Combined ring height shall not be less than 4" or exceed 12". The minimum ring thickness is 4". Grade rings shall match 24-inch diameter frame and cover.
 4. Steps: Per ASTM C478 plastic steps, individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals.
 5. Pipe Connectors: ASTM C 923 resilient, of size required, for each pipe connecting to base section. A-LOK manhole pipe connector or equal.
 - a. When connecting into an existing manhole, the manhole shall be cored drilled to allow new pipe to enter. Cutting or chipping the opening is not permitted. A rubber gasket and non-shrink grout shall be used to provide a tight seal around pipe.
- C. Manhole Frames and Covers: ASTM A48-76, Class 35.
 - a. Standard manhole frames and covers shall have a minimum weight of 300 pounds and shall be Neenah R-1642 or equal.
 - b. Bolt down manhole frames and covers shall have bolt down lid with waterproof gasket, minimum weight of 300 pounds, and shall be Neenah R-1916-F or approved equal.
 - c. Bolt down type manhole frames shall be anchored to the manhole with not less than four (4) ¾ inch diameter anchor bolts having a minimum of Eight inches of embedment into concrete.
 - d. Valve manhole frames and covers shall have a minimum weight of 300 pounds and shall be Neenah R-1752 or equal.
 - e. Include indented top design with lettering "SANITARY SEWER" cast into cover.

2.07 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.
- C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio. Include channels and benches in manholes.
 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope is to be 5 percent through manhole (minimum).
 2. Benches: Concrete, sloped to drain into channel. Slope must be 5 percent (minimum).

- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.08 PROTECTIVE COATINGS

- A. Refer to Section 07160 Bituminous Dampproofing for specifications on protective coatings.
- B. Refer to Section 07200 Protective Coating for Concrete Sanitary Sewer Structures for specifications on interior protective coatings.

2.09 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:
 - 1. Light Duty: In earth or grass foot-traffic areas.
 - 2. Medium Duty: In paved foot-traffic areas.
 - 3. Heavy Duty: In vehicle-traffic service areas.
 - 4. Extra-Heavy Duty: In roads.
 - 5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout. PVC Cleanout piping shall be Schedule 40.
- C. Cleanouts to be installed at right of way line, every 50 feet along service line and at connection to existing service line above septic tank.

2.10 MANHOLE REPAIR MATERIALS

- A. Polyurethane Grout: SealGuard II or approved equal
- B. Non-Shrink Grout: Conspec 100 or approved equal

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.02 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."
- B. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- C. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

3.03 IDENTIFICATION

Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

- A. Use warning tape or detectable warning tape over ferrous piping.
- B. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.04 PIPING APPLICATIONS

- A. General: Include watertight joints.
- B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.
- C. Gravity-Flow Piping: As indicated on the Drawings:
 - 1. NPS 4 and NPS 6: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints. (4-inch pipe is allowed on gravity service laterals from building to main line only.)
 - 2. NPS 8 to NPS 15: PVC sewer pipe and fittings, or gaskets and gasketed joints.
- D. Force-Main Piping: As indicated on the Drawings:
 - 1. NPS 4 to NPS 15: Ductile-iron sewer pipe; standard- or compact-pattern, ductile-iron fittings; gaskets; and gasketed joints.
 - 2. NPS 4 to NPS 15: PVC pressure pipe, PVC pressure fittings, gaskets, and gasketed joints.
 - 3. NPS 4 and larger: Polyethylene pressure pipe, polyethylene pressure fittings, fusion welded joints.

3.05 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

- A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
 - 1. Use the following pipe couplings for nonpressure applications:
 - a. Sleeve type to join piping, of same size, or with small difference in OD.
 - b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
 - c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
 - 2. Use pressure-type pipe couplings for force-main joints. Include PE film, pipe encasement.
- B. Special Pipe Fittings: Use where indicated. Include PE film, pipe encasement.

3.06 INSTALLATION, GENERAL

- A. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- B. All gravity sewer mains should be constructed to a minimum depth of thirty-six inches (36") or as required and as measured from the final ground surface to the top of the barrel of the pipe. Minimum depths of less than thirty-six inches (36") will be considered on a case by case basis by the Owner. Tracer wire is required on all gravity mains.

All force mains should be constructed to a minimum depth of forty-two inches (42") or as required and as measured from the final ground surface to the top of the barrel of the pipe. Minimum depths of less than forty-two inches (42") will be considered on a case by case basis by the Owner. Tracer wire is required on all force mains.

All service laterals, gravity or pressure, shall be constructed to a minimum depth of twenty four inches (24") and a minimum grade of one percent (1%). Service laterals shall provide adequate flow from the house to the main. Tracer wire is required on all service laterals, gravity or pressure.

- C. For gravity sewers, manholes with a minimum diameter of forty-eight inches (48") shall be installed at all changes in grade, size, alignment, intersections, and at distances of no greater than four hundred feet (400') unless indicated otherwise on the plans. The use of fittings in the place of manholes is not acceptable.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Molded Tees shall be used for all "tee" connections for new construction. Molded Tees with "knock-on" fittings shall be used for all "tee" connections on existing gravity sewers. and existing gravity sewers.
- F. Install ductile-iron, force-main piping according to AWWA C600. No rock greater than one (1) foot, measured along its longest axis, shall be placed within (2) feet of the top of a pipe in any backfill. No rocks greater than one (1) foot will be allowed in the backfill above service line terminations, tees and wyes. No ninety degree fittings are allowed.
- G. Install PVC force-main piping according to AWWA M23. No rock greater than one (1) foot, measured along its longest axis, shall be placed within (2) feet of the top of a pipe in any backfill. No rocks greater than one (1) foot will be allowed in the backfill above service line terminations, tees and wyes. No ninety degree fittings are allowed.
- H. Install Polyethylene force-main piping according to AWWA C906. No rock greater than one (1) foot, measured along its longest axis, shall be placed within (2) feet of the top of a pipe in any backfill. No rocks greater than one (1) foot will be allowed in the backfill above service line terminations, tees and wyes. No ninety degree fittings are allowed.
- I. Location of Sewers with Respect to Water Mains:
 - 1. Horizontal Separation – Sewer mains shall be laid at least ten feet (10') horizontally from any existing or proposed water line. The distance shall be measured edge-to-edge. In cases where it is not practical to maintain a ten foot (10') separation, the Missouri Department of Natural Resources may allow deviation on a case-by-case basis, if supported by data from the design engineer. This deviation may allow installation of the sewer closer to a water line, provided that the water line is in a separate trench or on an undisturbed earth shelf located on one (1) side of the sewer at an elevation that the bottom of the water line is at least eighteen inches (18") above the top of the sewer.
 - 2. Crossings – Sewer crossing water lines shall be laid to provide a minimum vertical distance of eighteen inches (18") between the outside of the water line and the outside of the sewer. This shall be the case where the water line is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water line joints. When a water line crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water line.
 - 3. Special Conditions – When it is impossible to obtain proper horizontal and vertical separation as stipulated previously, the sewer shall be designed and constructed of slip-on or mechanical joint ductile iron pipe or PVC pressure pipe for a distance of ten feet (10') on each side of the water line and shall be pressure tested to assure watertightness prior to backfilling.
 - 4. Sewer Manholes – No water pipe shall pass through or come into contact with any part of a sewer manhole.

- J. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- K. All gravity sewer lines shall be installed with slopes not less than the minimum slopes shown in the following table:

Sewer Size	Minimum Slope (Feet per 100 Feet)
6 in.	0.60
8 in.	0.40
9 in.	0.33
10 in.	0.28
12 in.	0.22
14 in.	0.17
15 in.	0.15
16 in.	0.14
18 in.	0.12
21 in.	0.10
24 in.	0.08
27 in.	0.067
30 in.	0.058
36 in.	0.046

- L. Cutting Pipe: Cut pipe in a neat manner without damage to pipe. Remove burrs and shape edges and smooth the pipe end by grinding. Repair lining where required and as approved.

3.07 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. Ductile-Iron Sewer Pipe with Ductile-Iron Fittings: According to AWWA C600. Install PE film, pipe encasement over ductile-iron sewer pipe and ductile-iron fittings if required according to ASTM A 674 or AWWA C105.
- C. PVC Pressure Pipe and Fittings: Join and install according to AWWA M23.
- D. PVC Gravity Sewer Pipe and Fittings: As follows:
1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
 2. Join profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.
 3. Install according to ASTM D 2321.
- E. Polyethylene Pipe and Fittings: Join and install according with ASTM D2321 or ASTM D2774 for pressure systems, AWWA Manual of Practice M55 Chapter 7 and the following:
1. Butt Fusion
The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.
 2. Saddle fusion
Saddle fusion shall be done in accordance with ASTM F 2620 or TR-41 or the fitting manufacturer's recommendations and PPI TR-41. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project. (ASTM F905).
 3. Electrofusion

Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290 and PPI TN 34. The process of electrofusion requires an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment to be utilized for this project.

4. Mechanical

- a. Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with the PPI Handbook of Polyethylene Pipe, Chapter 9 and AWWA Manual of Practice M55, Chapter 6.
- b. Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or a fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
- c. Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
- d. Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
- e. Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project.

5. Joint Recording

The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

- F. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.
- G. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.
- H. Install with top surfaces of components, except piping, flush with finished surface.

3.08 REACTION ANCHORAGE AND BLOCKING

- A. All unlugged bell and spigot or all-bell tees, Y-branches and bends deflecting 11-1/4 degrees or more which are installed in piping subjected to internal hydrostatic heads in excess of 15 feet in exposed, or 30 feet in buried, piping shall be provided with suitable reaction blocking, struts, anchors, clamps, joint harness, or other adequate means for preventing any movement of the pipe caused by unbalanced internal liquid pressure.
- B. Trench installation: Where in trench, the foregoing designated fittings shall be provided with concrete thrust blocking between the fitting and solid, undisturbed ground in each case, except where solid ground blocking support is not available. At the tops of slopes vertical angle bends shall be anchored by means of steel strap or rod anchors securely embedded in or attached to a mass of concrete of sufficient weight to resist the hydraulic thrust at the maximum pressures to which the pipe will be

subjected. All concrete blocking and anchors shall be installed in such a manner that all joints between pipe and fittings are accessible for repair.

- C. The bearing area of concrete reaction blocking against the ground or trench bank shall be as shown by the plans or as directed by the Engineer in each case. In the event that adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods or bolts across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities approved by the Engineer shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to careless or otherwise improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.
- D. For other locations: Reaction blocking, struts, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the plans or as directed by the Engineer.
- E. Protection of metal surfaces: All steel clamps, rods, bolts and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be adequately protected from corrosion with not less than two coats of Koppers "Bitumastic No. 50", or approved equal, heavy coal tar coating material, applied to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied. Metal surfaces exposed above grade or within structures shall be painted with two coats (in addition to a primer coat) of a paint approved by the Engineer.

3.09 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Form continuous concrete channels and benches between inlets and outlet. Manhole bottoms shall be formed to provide smooth continuous flow. Non shrink spout shall be used to form a smooth transition between downstream invert and channel of manhole.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Slope of frame and covers shall match slope of pavements both longitudinally and cross slope per frame and cover adjustment detail in construction plans.
- D. Set tops 3 inches (76 mm) above finished surface elsewhere, unless otherwise indicated.
- E. Install precast concrete manhole sections with gaskets according to ASTM C 891.
- F. Construct cast-in-place manholes as indicated.
- G. Backfill around manhole per specifications. No rock greater than one (1) foot, measured along its longest axis, shall be placed within (2) feet of the manhole.

3.10 REPAIR OF EXISTING MANHOLES

- A. Internal Repairs: Polyurethane Grout, repair water infiltration into manholes using polyurethane grout, SealGuard II or approved equal. Repair per manufacturer's instructions.
- B. External Repairs, Non-Shrink Grout, use to make minor repairs to manholes from outside the manhole only. Not to be used to repair water infiltration into the manhole from inside the manhole. Conspec 100 or approved equal.

3.11 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.12 BACKWATER VALVE INSTALLATION

- A. Install horizontal units in piping where indicated.
- B. Install combination units in piping and in structures where indicated.

3.13 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 6 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.14 AIR RELEASE FACILITIES

- A. Air release valves shall be A.R.I. model D-025 combination air valve for sewage.
- B. Air release facilities shall be located at the high points of all pressure sewer systems and shall be properly sized to prevent buildup of air or gases that will impede flow of the wastewater.
- C. Air release valves must be automatic and designed to prevent wastewater solids and grease from reaching the valve operating mechanism.
- D. Provisions for cleaning the valve by back flushing should be provided.

3.15 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.
- B. Use Inserta-Tees® (or approved equal) to make branch connections into existing piping, NPS 4 to NPS 20. Install Inserta-Tee® and encase entire connection with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- C. Make branch connections from side into existing piping, NPS 21 or larger, by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - 1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - 2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
- D. Protect existing piping to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.16 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 6-inch- thick non-shrink grout plug.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
 - 1. Remove structure and close open ends of remaining piping.
 - 2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
 - 3. Backfill to grade according to Division 2 Section "Earthwork."

3.17 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 - 1. Place plug in end of incomplete piping at end of day and when work stops.
 - 2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Re-inspect and repeat procedure until results are satisfactory.

3.18 FIELD TESTING

- A. General:
 - 1. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 2. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- B. Pressure Tests:
 - 1. The Contractor shall furnish all pumps, piping, labor and other materials and services necessary to bring the piping up to the specified test pressure.
 - 2. All pipes shall be pressure tested. Pipes which will be pressurized under normal operating conditions shall conform to the requirements of the hydrostatic pressure test. All other piping shall meet the requirements of the air leakage test.

3. Pipe in the sections to be tested shall be backfilled or center loaded, with thrust blocks installed and completely backfilled. Interior pipe supports and restraint systems shall be completely installed prior to testing.

C. Hydrostatic Pressure Test:

1. Test connections shall be made and the pipe filled with water. Unless otherwise specified, a pressure of 1.50 times the normal operating pressure (for the lowest point on the pipe line) but not less than the greater of 1.25 times the normal operating pressure or 150 pounds per square inch (psi). In no case shall the test pressure be allowed to exceed the design pressure for the pipe, appurtenances, or thrust restraints.
2. After air removal, water shall be pumped in to bring the pipe to the specified pressure. The hydrostatic test shall be of at least a 2-hour duration. Test pressure shall not vary by more than 5 psi for the duration of the test. After two hours, additional water shall be drawn from a container of known volume. The amount of water required to return the system to the specified pressure shall not exceed the amount determined by the following formula:

$$L = ND(P)^{1/2}/7,400, \quad \text{(Equation 1, AWWA C605-94)}$$

Where

L - Allowable leakage, in gallons per hour
 N - Number of joints in the length of pipeline tested
 D - Nominal pipe diameter, inches
 P - Average test pressure, psi (gauge)

The allowable leakage must not exceed the volumes specified below for 50 joints of the particular diameter of pipe being tested:

**Allowable Leakage per 50 joints of Pipe* - gph
(AWWA C-600)**

Avg. Test Pressure (psi)	Nominal Pipe Diameter (in)										
	1.5	2	3	4	6	8	10	12	14	16	18
300	0.18	0.23	0.35	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11
275	0.17	0.22	0.34	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02
250	0.16	0.21	0.32	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92
225	0.15	0.20	0.30	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82
200	0.14	0.19	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72
175	0.13	0.18	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61
150	0.12	0.17	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49

3. All exposed pipe, fittings, valves, and joints shall be inspected and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation where the pipe has been covered with backfill. Should the leakage test results exceed allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the Engineer to facilitate location of leaks.
4. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective when the pipe line is tested shall be removed from the line immediately and replaced with new and acceptable material by and at the expense of the Contractor. The pressure test shall be repeated after repairing leaks and other defective work until the pipe line installation conforms to specified requirements and is accepted by the Engineer.

D. Air Leakage Test:

1. Contractor may perform air tests for all pipe sizes.
2. Air leakage testing shall be performed on lines as specified and on the following lines:

- a. Outfall line.
 - b. Drain lines.
 - c. Sanitary sewer lines.
3. Furnish all facilities required including necessary piping connections, test pumping equipment, pressure gauges, bulkheads, regulator to avoid over-pressurization, and all miscellaneous items required.
 - a. The pipe plug for introducing air to the line shall be equipped with two taps. One tap will be used to introduce air into the line being tested, through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. An additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.
 - b. The pressure test gauge shall meet the following minimum specifications:
 - i. Size (diameter) 4-1/2 inches
 - ii. Pressure Range 0-15 P.S.I.
 - iii. Figure Intervals 1 P.S.I. Increments
 - iv. Minor Subdivisions 0.05 P.S.I.
 - v. Pressure Tube Bourdon Tube or diaphragm
 - vi. Accuracy + 0.25% of maximum scale reading
 - vii. Dial White coated aluminum with black lettering, 270° Arc and mirror edge
 - viii. Pipe Connection Low male 1/2" N.P.T.Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification and calibration data will be available to the Engineer whenever air tests are performed.
4. Test each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trench.
5. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the time, in seconds, for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Minimum Specified Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for Q =
0.0015

(ASTM F 1417, TABLE 1)

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:3
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:5	115:2	129:4
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:5	124:3	142:2	160:1
33	31:10	72	25.852L	43:05	64:38	86:10	107:4	129:1	150:4	172:2	193:5
36	34:00	66	30.768L	51:17	76:55	102:3	128:1	153:5	179:2	205:0	230:4

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired. Prior to acceptance, all constructed sewer lines shall satisfactorily pass the pressure air test.

- In areas where ground water is known to exist, install a one half inch diameter capped pipe nipple, approximately 10" long, through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test, ground water level shall be determined by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertically and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

E. Vacuum Testing of Manholes:

- Each manhole shall be tested immediately after assembly and prior to backfilling.
- All lift holes shall be plugged with an approved non-shrink grout.
- All pipes entering the manhole shall be plugged, taking care to securely brace the plug 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 manufacturers' recommendations. Test head shall be as manufactured by P.A. Glazier, Inc., of Worcester, Massachusetts, or equal.
- 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 9 inches. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in the following table:

**Minimum Test Times for Various Manhole Diameters in Seconds
(ASTM C 1244, TABLE 1)**

Depth (ft)	Manhole Diameter, in.								
	30	33	36	42	48	54	60	66	72
Time, in seconds									
8	60	60	60	60	60	60	60	60	60
10	60	60	60	60	60	60	60	60	60
12	60	60	60	60	60	60	60	60	60
14	60	60	60	60	60	60	60	60	60
16	60	60	60	60	60	60	60	60	67
18	60	60	60	60	60	60	60	65	73
20	60	60	60	60	60	60	65	72	81
22	60	60	60	60	60	64	72	79	89
24	60	60	60	60	60	64	78	87	97
26	60	60	60	60	64	75	85	94	105
28	60	60	60	60	69	81	91	101	113
30	60	60	60	63	74	87	98	108	121

6. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Re-testing shall proceed until a satisfactory test is obtained.

F. Deflection Tests:

1. Deflection tests shall be performed on all flexible sewer pipe by the Contractor using a mandrel pull. The mandrel shall have not less than seven (7) arms. The mandrel pull cannot be performed any sooner than 30 days after the reach being tested has been installed and final backfill has been placed.
2. A section of sewer line reach shall be deemed as failed when the mandrel cannot be moved through it with reasonable force. The tests shall be performed without mechanical pulling devices.
3. At the conclusion of the mandrel pull, the Contractor, at his expense, shall be required to remove and replace all pipe which fails the test.
4. The mandrel diameter shall be based on 95% of the actual inside pipe diameter.

- G. Alignment Tests: Sewer alignment shall be checked by using a laser beam or lamping.

END OF SECTION

SECTION 02537 – INSTALLATION OF TRACE WIRE

PART 1 – GENERAL

- 1.01** This Construction Standard governs trace wire installation on sewage lines. Trace wire shall be installed on top of all mains and service lines.

PART 2 – PRODUCTS

2.01 EXTRA TRACE WIRE MATERIAL

- A. Trace wire shall be #12 TW solid, coated copper wire.
- B. 8 ft PVC pipe posts.
- C. Valve Box Top Sections.
- D. Plastic test box.
- E. Wire Nuts or Split-Bolts.

PART 3 – EXECUTION

3.01 APPROVED TRACE WIRE CONNECTIONS

When tying trace wire together, $\frac{3}{4}$ " to 1" of insulation should be removed and the bare copper wires twisted together with a wire nut. Taney County Regional Sewer District Standard Detail 67, Fig 1 shows a typical splice using a plastic wire nut and tying the wire in a knot to strengthen the connection. When connecting a lead to the main run, a split-bolt may be used as shown in Taney County Regional Sewer District Standard Detail 67, Fig. 2. Alternately, a 3M Scotchlok Electrical IDC 562 (or approved equal) can be used when connecting a lead to the main run. Always protect the connection with electrical tape when using the split-bolt. Alternately, 3M Heat Shrink Sleeves (or approved equal) can be used instead of electrical tape.

3.02 INSTALLATION

Install trace wire on top of all mains and service lines and secure to pipe every five (5) feet with tape as shown in Taney County Regional Sewer District Standard Detail 67, Fig 3. Provide trace wire on each service line with an access point in a protective enclosure.

Bring trace wire to surface at a maximum spacing of one thousand (1,000) feet. The trace wire shall be brought to the surface in a vault, plastic marker, valve box top section, or in test box. Take care not to damage the wire coating. Repair damaged coating with electrical tape. Splice wire when necessary using wire nuts or split bolts. Terminate old wire runs and begin new ones at an approved access point.

Trace Wire in a Vault or Manhole

When using a vault, bring the trace wire to the surface according to Taney County Regional Sewer District Standard Details. Do not wrap the trace wire around the steps or any other place where a person entering the vault could trip.

When installing trace wire on gravity main, terminate the trace wire outside the manhole and bring the wire to the surface. Do not wrap the trace wire around the steps or any other place where a person entering the manhole could trip.

Trace Wire in Plastic Marker

When bringing the trace wire up in a plastic marker, install the trace wire according to Taney County Regional Sewer District Standard Detail 67, Fig 4. Bury an 8- foot PVC pipe post 3 feet in the ground. Run the trace wire up through the pipe and place a PVC cap over the pipe. Provide a 12-inch pigtail on each end of the tracer wire through drilled holes in the PVC pipe post. Note location of trace wire marker on as-built drawings.

Note: If a marker is used only to mark the main location and not bring up the trace wire, use the markers without the drilled pigtail holes.

Trace Wire in a CC Valve Box

When installing the trace wire at a valve box, install the trace wire up through the valve box keeping wire to one side, allowing wire not to entangle with valve wrench when used. Make sure there is enough coiled wire to extend a foot above ground.

Trace Wire in a Valve Box Top Section

When trace wire is to be brought to the surface in an area where a marker is not practical, a valve box top section may be used. Coil enough wire to extend a foot above the surface of the ground. Fill with sand to a foot from the top. Note location of trace wire box on as-built drawings.

END OF SECTION

SECTION 02540 – LOW PRESSURE SEWER SYSTEMS

PART 1 – GENERAL

1.01 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene-monomer rubber.
- B. NPS: Nominal pipe size.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.02 PERFORMANCE REQUIREMENTS

- A. Low Pressure Sewer Ratings: At least equal to system operating pressure, but not less than 150 psig.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Valves and cleanouts.
 - 2. Concrete structure cover inserts.
 - 3. Pipes and fittings.
- B. Shop Drawings: Include plans, elevations, details, and attachments for precast concrete structures, including frames and covers to be submitted to the Sewer District upon approval of the design engineer.
- C. Record Drawings: At Project closeout of installed sanitary sewerage record drawings shall be submitted to the Sewer District. The record drawings shall accurately record actual locations of pipe runs, connections, cleanouts, air-relief valves and grinder pump data. Identify and describe location of uncharted utilities.
- D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver piping and valves with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- C. Protect flanges, fittings and specialties from moisture and dirt.
- D. Store plastic piping protected from direct sunlight. Support piping to prevent sagging and bending.
- E. Handle precast concrete structures according to manufacturer's written rigging instructions.

1.05 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated. Notify Sewer District and affected property owners not less than two days in advance of proposed utility interruptions.

PART 2 – PRODUCTS

2.01 PIPING MATERIALS

Refer to Part 3 “Piping Applications” Article for applications of pipe and fitting materials.

2.02 PIPES AND FITTINGS

- A. PVC Pressure Pipe (NPS 4 inch and larger): AWWA C900, Class 200 or ASTM 2241, 200 psi, SDR 21.
 - 1. Ductile-Iron, Compact Fittings: AWWA C153, for push-on joints.
 - 2. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.
- B. PVC Pressure Pipes (NPS 1-¼ inch to 3 inch): ASTM 1785, Schedule 80 PVC
 - 1. Molded PVC Fittings suitable for pressurized conditions with a pressure rating not less than the pipe; minimum of Schedule 80; solvent-cemented joints.
- C. PVC Gravity Service Lines: ASTM 1785, Schedule 40.
 - 1. Joints shall be push-on type with bell-end grooved to receive a synthetic rubber gasket. Joints shall be made in accordance with ASTM D 3212.

2.03 VALVES AND ACCESSORIES

- A. Nonrising-Stem, Resilient-Seated Gate Valves (3 inch NPS and Larger):
 - 1. AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Include 200-psig minimum working-pressure design, interior coating according to AWWA C550, and buried valves shall be mechanical-joint with a 2-inch operating nut, exposed or interior valves shall have flanged ends and have hand wheel operators. Valves shall open counter clockwise. Valve stems shall use double "O" ring seals.
- B. Check Valves (4 inch NPS and Larger):
 - 1. AWWA C508, with 175-psig working-pressure rating. Include interior coating according to AWWA C550. Valve hinge pins shall be stainless steel. Valve disc shall be full opening with a composition to metal seat. Valve shall be flanged unless noted otherwise on the Drawings. Valves shall be equipped with an external lever that is spring assisted. The spring tension shall be field adjustable by a hex nut. The lever arm shall be keyed to the valve hinge shaft.
- C. Check Valves – Cushioned (4 inch NPS and Larger):
 - 1. AWWA C508, with 175-psig working- pressure rating, with addition of exterior cushion chamber. Include interior coating according to AWWA C550. Swing disc type with stainless steel shaft and flanged body. Flanges shall be ANSI B16.1, Class 125. Valve disc shall have external lever and adjustable counterweight to initiate closure. Valves shall have a metal to composition seat.

- D. Check Valves (1-¼ inch to 3 inch NPS):
 - 1. All thermoplastic check valves shall be True Union 2000 Industrial Ball Check type manufactured to ASTM F 1970 and constructed from PVC Type I, ASTM D1784, Cell Classification 12454 or CPVC Type IV, ASTM D1784 Cell Classification 23447.
 - 2. All O-rings shall be EPDM.
 - 3. All valve union nuts shall have Buttruss threads.
 - 4. All valve seats shall be a standard O-ring type.
 - 5. All seal carriers shall be Safe-T-Blocked® or approved equal.
 - 6. All valve components shall be replaceable.
 - 7. All PVC and CPVC 1-¼" through 2" valves shall be pressure rated to 235 psi.
 - 8. All 2-½" through 3" valves shall be pressure rated to 150 psi for water at 73°F.
- E. Ball Valves (1-¼ Inch to 3 Inch NPS):
 - 1. All thermoplastic ball valves shall be True Union 2000 Industrial type manufactured to ASTM F 1970 and constructed from PVC Type I, ASTM D1784 Cell Classification 12454 or CPVC Type IV, ASTM D1784 Cell Classification 23447.
 - 2. All O-rings shall be EPDM or Viton®.
 - 3. All valves shall have Safe-T-Shear® stem or approved equal with double O-ring stem seals.
 - 4. All valve handles shall be polypropylene with built-in lockout mechanism.
 - 5. All valve union nuts shall have Buttruss threads.
 - 6. All seal carriers shall be Safe-T-Blocked® or approved equal.
 - 7. All valve components shall be replaceable.
 - 8. All 1-¼" through 2" valves shall be pressure rated to 235 psi.
 - 9. All 2-½" through 3" valves shall be pressure rated to 150 psi for water at 73°F.
- F. Air Release Valves:
 - 1. Air release valves shall be A.R.I. model D-025 combination air valve for sewage, or as required by manufacturer to meet project conditions for each application.
- G. Appurtenances:
 - 1. Trace Wire: See Section 02537 for Tracer Wire Specification.

2.04 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.
- C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.05 PROTECTIVE COATINGS

- A. Description: One- or two-coat, coal-tar epoxy; 1/8 inch minimum thickness, unless otherwise indicated; factory or field applied to the following surfaces (Refer to Section 07160 Bituminous Dampproofing):
 - 1. Concrete Structures: On exterior surface.

2.06 VALVE BOXES

- A. Valve boxes shall be constructed of a minimum of Class 200 PVC pipe with metal lid and shall be provided for all valves installed underground.
- B. All valve boxes shall be installed flush with the ground surface.

2.07 PRESSURE MAIN CLEANOUTS

- A. In-line cleanouts shall include an isolating valve, capped Y-branch fitting located on either side of the isolating valve, and shall be pointed both upstream and downstream for access during maintenance procedures.
- B. Cleanouts at the junction of pressure mains shall include an isolating valve and capped Y- branch fitting located on all sides of the tee connection.

2.08 PRESSURE MAIN CLEANOUT STRUCTURES

- A. Cleanout structures shall be constructed per standard details in the Contract Drawings.

2.09 GRAVITY SERVICE CLEANOUTS

- A. Gravity PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout. PVC Cleanout piping shall be Schedule 40.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations area as indicated on Construction Drawings.

3.02 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."
- B. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- C. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

3.03 IDENTIFICATION

Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

- A. Use warning tape or detectable warning tape over ferrous piping.

- B. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.04 PIPING APPLICATIONS

- A. General: Include watertight joints.
- B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.
- C. Low Pressure Piping (As indicated on the Drawings):
 - 1. 4-Inch NPS and Larger: PVC pressure pipe, PVC pressure fittings, gaskets, and gasketed joints.
 - 2. NPS 1-¼ inch to 3 inch: PVC pressure pipe, PVC pressure fittings, manufacturer recommended pipe cement and bell joints.
 - 3. The minimum diameter of the pressure sewer main shall be 1-½ inch.
 - 4. The minimum diameter of the pump discharge line shall be 1-¼ inch.

3.05 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. All pressure sewer mains should be constructed to a minimum depth of forty-two inches (42") or as required and as measured from the final ground surface to the top of the barrel of the pipe. Minimum depths of less than forty-two inches (42") will be considered on a case by case basis by the Owner. All low pressure sewer service laterals should be constructed to a minimum depth of twenty-four (24") or as required and as measured from the final ground surface to the top of the barrel of the pipe.
- D. Use fittings for changes in direction. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- E. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- F. Location of Sewers with Respect to Water Mains:
 - 1. Horizontal Separation – Sewer mains shall be laid at least ten feet (10') horizontally from any existing or proposed water line. The distance shall be measured edge-to-edge. In cases where it is not practical to maintain a ten foot (10') separation, the Missouri Department of Natural Resources may allow deviation on a case-by-case basis, if supported by data from the design engineer. This deviation may allow installation of the sewer closer to a water line, provided that the water line is in a separate trench or on an undisturbed earth shelf located on one (1) side of the sewer at an elevation that the bottom of the water line is at least eighteen inches (18") above the top of the sewer.
 - 2. Crossings – Sewer crossing water lines shall be laid to provide a minimum vertical distance of eighteen inches (18") between the outside of the water line and the outside of the sewer. This shall be the case where the water line is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water line joints. When a water line crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water line.

3. Special Conditions – When it is impossible to obtain proper horizontal and vertical separation as stipulated previously, the sewer shall be designed and constructed of slip-on or mechanical joint ductile iron pipe or PVC pressure pipe for a distance of ten feet (10') on each side of the water line and shall be pressure tested to assure watertightness prior to backfilling.
 4. Sewer Manholes – No water pipe shall pass through or come into contact with any part of a sewer manhole.
- G. Install PVC low pressure piping according to AWWA M23.
- H. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- I. Termination of pressure mains: Pressure mains shall terminate in manholes using the following construction procedures:
1. The discharge shall be to the bottom of the manhole in line with the flow if possible.
 2. Where piping must be installed to bring the discharge to the bottom of the manhole, the pipe shall be adequately braced to prevent movement, shall be vented on the top and shall allow access to the pressure main for cleaning purposes.
- J. Two 45 degree bends shall be used to accomplish a 90 degree bend.

3.06 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. PVC Pressure Pipe and Fittings: Join and install according to AWWA M23.
- C. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.
- D. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.
- E. Install with top surfaces of components, except piping, flush with finished surface.

3.07 REACTION ANCHORAGE AND BLOCKING

- A. All unlugged bell and spigot or all-bell tees, Y-branches and bends deflecting 11-1/4 degrees or more which are installed in piping subjected to internal hydrostatic heads in excess of 15 feet in exposed, or 30 feet in buried, piping shall be provided with suitable reaction blocking, struts, anchors, clamps, joint harness, or other adequate means for preventing any movement of the pipe caused by unbalanced internal liquid pressure.
- B. Trench installation: Where in trench, the foregoing designated fittings shall be provided with concrete thrust blocking between the fitting and solid, undisturbed ground in each case, except where solid ground blocking support is not available. At the tops of slopes vertical angle bends shall be anchored by means of steel strap or rod anchors securely embedded in or attached to a mass of concrete of sufficient weight to resist the hydraulic thrust at the maximum pressures to which the pipe will be subjected. All concrete blocking and anchors shall be installed in such a manner that all joints between pipe and fittings are accessible for repair.
- C. The bearing area of concrete reaction blocking against the ground or trench bank shall be as shown by the plans or as directed by the Engineer in each case. In the event that adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods or bolts across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities

approved by the Engineer shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to careless or otherwise improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.

- D. For other locations: Reaction blocking, struts, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the plans or as directed by the Engineer.
- E. Protection of metal surfaces: All steel clamps, rods, bolts and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be adequately protected from corrosion with not less than two coats of Koppers "Bitumastic No. 50", or approved equal, heavy coal tar coating material, applied to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied. Metal surfaces exposed above grade or within structures shall be painted with two coats (in addition to a primer coat) of a paint approved by the Engineer.

3.08 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.09 PRESSURE MAIN CLEANOUT INSTALLATION

- A. Pressure systems shall have in-line flushing assemblies or cleanouts at the end of each main, intervals of approximately four hundred to five hundred feet (400' to 500') on straight runs, at major changes of direction, and where two or more mains come together and feed into another main.

3.10 GRAVITY SERVICE CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.11 AIR RELEASE FACILITIES

- A. Air release valves shall be A.R.I. model D-025 combination air valve for sewage.
- B. Air release facilities shall be located at the high points of all pressure sewer systems and shall be properly sized to prevent buildup of air or gases that will impede flow of the wastewater.
- C. Air release valves must be automatic and designed to prevent wastewater solids and grease from reaching the valve operating mechanism.
- D. Provisions for cleaning the valve by back flushing should be provided.

3.12 TAP CONNECTIONS

- A. All connections to existing piping and underground structures shall be in accordance with the Drawings.

- B. Connections to existing sewer mains (including installation of tees and live taps) must be approved by the District before construction can take place.
- C. Connections to existing sewer lines shall be performed in such a manner as to minimize disruption to customers.
- D. Notify District within 5 working days in intent to tie-in to existing sewer.
- E. District shall be present for the construction of the connection to existing sewer.
- F. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.13 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
 - 1. Remove structure and close open ends of remaining piping.
 - 2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
 - 3. Backfill to grade according to Division 2 Section "Earthwork."

3.14 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 - 1. Place plug in end of incomplete piping at end of day and when work stops.
- B. Inspect interior of piping to determine whether damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - b. Crushed, broken, cracked, or otherwise damaged piping.
 - c. Infiltration: Water leakage into piping.
 - d. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Re-inspect and repeat procedure until results are satisfactory.

3.15 FIELD TESTING

- A. General:
 - 1. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 2. Leaks and loss in test pressure constitute defects that must be repaired.

3. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- B. Pressure Tests:**
1. The Contractor shall furnish all pumps, piping, labor and other materials and services necessary to bring the piping up to the specified test pressure.
 2. All pipes shall be pressure tested. Pipes which will be pressurized under normal operating conditions shall conform to the requirements of the hydrostatic pressure test. All other piping shall meet the requirements of the air leakage test.
 3. Pipe in the sections to be tested shall be backfilled or center loaded, with thrust blocks installed and completely backfilled. Interior pipe supports and restraint systems shall be completely installed prior to testing.
- C. Hydrostatic Pressure Test:**
1. Test connections shall be made and the pipe filled with water. Unless otherwise specified, a pressure of 1.50 times the normal operating pressure (for the lowest point on the pipe line) but not less than the greater of 1.25 times the normal operating pressure or 150 pounds per square inch (psi). In no case shall the test pressure be allowed to exceed the design pressure for the pipe, appurtenances, or thrust restraints.
 2. After air removal, water shall be pumped in to bring the pipe to the specified pressure. The hydrostatic test shall be of at least a 2-hour duration. Test pressure shall not vary by more than ± 5 psi for the duration of the test. After two hours, additional water shall be drawn from a container of known volume. The amount of water required to return the system to the specified pressure shall not exceed the amount determined by the following formula:

$$L = ND(P)^{1/2} / 7,400, \quad \text{(Equation 1, AWWA C605-94)}$$

Where

L - Allowable leakage, in gallons per hour
 N - Number of joints in the length of pipeline tested
 D - Nominal pipe diameter, inches
 P - Average test pressure, psi (gauge)

The allowable leakage must not exceed the volumes specified below for 50 joints of the particular diameter of pipe being tested:

**Allowable Leakage per 50 joints of Pipe* - gph
(AWWA C-600)**

Avg. Test Pressure (psi)	Nominal Pipe Diameter (in)										
	1.5	2	3	4	6	8	10	12	14	16	18
300	0.18	0.23	0.35	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11
275	0.17	0.22	0.34	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02
250	0.16	0.21	0.32	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92
225	0.15	0.20	0.30	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82
200	0.14	0.19	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72
175	0.13	0.18	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61
150	0.12	0.17	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49

3. All exposed pipe, fittings, valves, and joints shall be inspected and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation where the pipe has been covered with backfill. Should the leakage test results exceed

allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the Engineer to facilitate location of leaks.

4. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective when the pipe line is tested shall be removed from the line immediately and replaced with new and acceptable material by and at the expense of the Contractor. The pressure test shall be repeated after repairing leaks and other defective work until the pipe line installation conforms to specified requirements and is accepted by the Engineer.

END OF SECTION

SECTION 02820 – CHAIN LINK FENCE

PART 1 – GENERAL

1.01 SUMMARY

- A. Fencing shall be chain link with three-strand barbed wire extension provided in the alignment indicated on the drawings.
- B. The height shall be as shown on the drawings.

1.02 SUBMITTALS

- A. Submit manufacturer's product specifications and installation instructions.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Framework: Type I or Type II Steel Pipe.
 - 1. Type I – Schedule 40 steel pipe with 1.8 ounces of zinc coating per square foot or surface area conforming to Standard specification ASTM F1083; or
 - 2. Type II – Pipe manufactured from steel conforming to ASTM A569, cold-formed, high frequency or induction welded and having a minimum yield strength of 50,000 PSI. External surface triple coated per ASTM F1043, Type B with 1.0 ounce +/-0.1 ounce of zinc per square foot, 30 +/-15 micrograms of chromate per square inch and high-performance polymer and shall demonstrate the ability to resist 1,000 hours of exposure to salt spray with maximum of 5% red rust in a test conducted in accordance with ASTM B117. Internal surface coated per ASTM F1043, Type B or Type D coating.
 - 3. All coatings to be applied inside and out after welding.
 - 4. Pipe shall be straight, true to section and conform to the following weights:

Pipe Size Outside Diameter	Type I Weight Lbs/Ft.	Type II Weight Lbs/Ft.
1-5/8"	2.27	1.84
2"	2.72	2.28
2-1/2"	3.65	3.12
3"	5.79	4.64
3-1/2"	7.58	5.71
4"	9.11	6.56
6-5/8"	18.97	--

- B. Fabric:
 - 1. Fabric to be zinc-coated 9 gauge wire woven in a 2" diamond mesh.
 - 2. Top selvage shall be twisted and barbed. Bottom selvage shall be knuckled.
 - 3. Fabric shall be galvanized after weaving with a minimum 2.0 ounces of zinc per square foot of surface area and conform to ASTM A392, Class II.

2.02 CONCRETE MIX

- A. ASTM C 94 Portland Cement concrete, air entrained, with maximum 3/4" aggregate having a minimum compressive strength of 4,000 PSI at 28 days. Conform to Division 3 specification requirements.

2.03 COMPONENTS

A. Fence Posts:

Fabric Height	Type I - II	
	Line Post O.D.	Terminal Post O.D.
Under 6'	2"	2-1/2"
6' to 9'	2-1/2"	3"
9' to 12'	3"	4"

B. Gate Posts:

Single Gate Width	Double Gate O.D.	Post O.D. Type II
Up to 6'	Up to 12'	4"
Up to 16'	13' to 25'	6 5/8"

C. Rails and Braces : 1-5/8" O.D.

D. Gates: Frame assembly of 2" O.D. pipe Type I or Type II with welded joints, conforming to ASTM F900. Weld areas repaired with zinc-rich coating applied per manufacturer's directions. Fabric to match fence. Gate accessories, hinges, latches, center stops, keepers and necessary hardware of quality required for industrial and commercial application. Latches shall permit padlocking.

E. Fittings:

1. Post Caps – Pressed steel, cast iron or cast aluminum alloy designed to fit snugly
 - i. over posts to exclude moisture. Supply cone type caps for terminal posts and loop
 - ii. type for line posts. All fittings shall conform to ASTM F626.
2. Rail and Brace Ends – Pressed steel, cast iron or cast aluminum alloy, cup-shaped
 - i. to receive rail and brace ends.
3. Top Rail Sleeves – Tubular steel, 0.051 thickness x 7" long, expansion type.
4. Tension Bars – Steel strip, 5/8" wide x 3/4" thick.
5. Tension Bands – Pressed steel, 14 gauge thickness x 3/4" wide.
6. Brace Bands – Pressed steel, 12 gauge thickness x 3/4" wide
7. Truss Rods – Steel rod, 3/8" diameter merchant quality with turnbuckle.
8. Barbed Wire Arms – Pressed steel, cast iron or cast aluminum alloy fitted with clips
 - (a) or slots for attaching three strands or barbed wire. Arms shall be set outward on a 45 degree
 - (b) angle and be capable of supporting a 250 pound load at outer barbed wire connecting point
 - (c) without causing permanent deflection.

F. Tension Wire: Marcellled 7 gauge steel wire minimum coating of 0.80 ounces of zinc or 0.40 ounces of aluminum per square foot of wire surface and conforming to ASTM A824.

G. Tie Wires: Aluminum, 9 gauge, alloy 1100-H4 or equal.

H. Hog Rings: Steel wire, 11 gauge, with a minimum zinc coating or 0.80 ounces per square foot of wire surface.

- I. Barb Wire: Commercial quality steel, 12-1/2" gauge, two-strand twisted line wire with 4-point barbs at 5-inch spacing. Coating shall consist of a minimum of 0.80 ounces of zinc per square foot of wire surface conforming to ASTM A121 or a minimum of 0.30 ounces of aluminum per square foot of wire surface conforming to ASTM A-585.
- J. Padlocks: Keyed alike for all gates, provided 4 keys for each padlock required.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for adjustments during installation where taking field measurements before fabrication might delay work.

3.02 INSTALLATION

- A. General:
 - 1. Conform to ASTM F567, except as modified herein.
 - 2. Conform to the alignment and finished grade indicated on the drawings. Fill, cut, or grade where necessary to produce a smooth and uniform ground surface so the bottom of the fence fabric is not more than 2-inch clearance above the finished ground line. All posts shall be plumb true to line and grade and installed in concrete footings. Unless otherwise shown on the drawings or required, posts shall be spaced 10 feet apart.
 - 3. Concrete footings for line and terminal posts shall be 42 inches deep. Concrete footings for gate posts shall be 54 inches deep or as shown on the drawings. Concrete footings shall be circular in horizontal section, with the diameter not less than 4 times the post O.D. Concrete footings shall be of a uniform thickness around the post, shall extend above the finish ground surface, and shall be crowned approximately one inch. Concrete for footings shall conform to Specification Division 03. Each footing shall be cured for at least 72 hours before further work is done on the post.
 - 4. Top rails and bottom tension wires shall be installed before the fence fabric. Top rails shall be securely connected to gate and terminal posts. Tension wires shall be installed approximately 6 inches above the finished grade and shall be attached to each post and securely anchored at terminal and gate posts.
 - 5. Attach fabric to the top rail and bottom tension wire at 24 inches centers and to the line posts at 15-inch centers. Fasten barbed wire to each extension arm by internal clips or external fabric ties. Provide stretcher bars at each gate and terminal post. Each stretcher bar shall be threaded through the fabric and anchored to the post at 15-inch centers. All fabric shall be stretched taut before it is attached to line posts or tension wire.
 - 6. Brace each gate and terminal post by a horizontal pipe brace and an adjustable truss extending to an adjacent line post. Brace corner posts in both directions.
- B. Gates:
 - 1. Gates shall be swing type, hinged to swing 180 degrees from closed to open, complete with frames, latches, stops, keepers, hinges, fabric, braces, padlocks, and three strands of barbed wire. Gate leaves shall have intermediate members and diagonal truss rods required for rigid construction and shall be free from sag or twist. Gates shall be fitted with vertical extension arms or shall have frame end members extended to carry barbed wire. Joints between frame members shall be made by welding or by means of heavy fittings and shall be rigid and watertight. Gate fabric shall be the same as fence fabric and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means.
 - 2. Hinges shall be heavy pattern with large bearing surfaces and shall not twist or turn under the action of the gate. Latches shall be plunger bar type, full gate height, and arranged to engage the

gate stop, except single gates less than 8 feet wide may be provided with a forked latch. Latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Stops shall consist of a roadway plate with anchor set in concrete and arranged to engage the plunger. Keepers shall consist of mechanical devices for securing and supporting the free end of the gates when in full open position.

3. Install gates so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.

END OF SECTION

SECTION 02920 – LAWNS AND GRASSES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Sections includes the following:
 - 1. Soil Preparation
 - 2. Seeding
 - 3. Sodding
 - 4. Meadow grasses
 - 5. Lawn renovation
 - 6. Maintenance

1.02 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.
- E. Lawns: Areas of grass that are currently manicured and maintained
- F. Meadows: Areas that are not manicured containing trees, brush, and native grasses left in natural condition.

1.03 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.
 - 1. Certification of each seed mixture for identifying source, including name and telephone number of supplier.
- C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- D. Qualification Data: For landscape Installer.
- E. Material Test Reports: For existing surface soil and imported topsoil.
- F. Planting Schedule: Indicating anticipated planting dates for each type of planting.
- G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.05 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 1st to June 1st
 - 2. Fall Planting: August 15th to November 1st
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.06 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 - 1. Seeded Lawns: 60 days from date of Substantial Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
 - 2. Sodded Lawns: 30 days from date of Substantial Completion.
 - 3. Plugged Lawns: 30 days from date of Substantial Completion.
 - 4. Sprigged Lawns: 30 days from date of Substantial Completion.
- B. Maintain and establish lawn by watering, fertilizing, weeding, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: It is the Contractor's responsibility to provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from approved sources and to keep lawn uniformly moist to a depth of 4 inches. This may require coordination with Property Owners.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
 - 2. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 3. Water lawn at a minimum rate of 1 inch per week until acceptance.

1.07 MEADOW MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 40 days from date of Substantial Completion.
- B. Maintain and establish meadow by watering, weeding, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from approved sources and to keep meadow uniformly moist.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
 - 2. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 3. Water meadow at a minimum rate of 1/2 inch per week until acceptance.

1.08 MAINTENANCE – GENERAL

- A. Maintenance of lawns shall be ongoing during the project period and during fall and spring seeding seasons during the warranty period until a hardy stand of grass is established per section 3.09 of this specification.

PART 2 – PRODUCTS

2.01 LAWN GRASSES

- 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 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Full Sun, High Traffic: Bermuda grass mix (warm season).
 - 2. Full Sun: Turf type fescue blend.
 - 3. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Turf Type Fescue Blend.
 - b. 35 percent Chewings Red Fescue (*Festuca rubra* variety).
 - c. 15 percent Annual Rye Grass.
- C. Shade: Proportioned by weight as follows:
 - 1. 50 percent Chewings Red Fescue (*Festuca rubra* variety).
 - 2. 35 percent Turf Type Fescue Blend.
 - 3. 15 percent Annual Rye Grass.

2.02 MEADOW GRASSES

- A. Native Grass Seed: Fresh clean, dry, new seed, mixed species as follows:
 - 1. 20 percent Buffalo Grass
 - 2. 15 percent Little Bluestem
 - 3. 15 percent Side Oats Gramma
 - 4. 15 percent Indian Grass
 - 5. 15 percent Switch Grass
 - 6. 10 percent Annual Rye Grass
 - 7. 10 percent Purple Coneflower
 - a. Native Grass Seed to be sown at a rate of 150 lbs/acre.
 - b. Pasture Grass Seed to be sown at rate indicated by Property Owner.
- B. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.03 TURFGRASS SOD

- A. Turfgrass Sod: Approved Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Full Sun: Turf type fescue blend.

2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Turf Type Fescue Blend.
 - b. 35 percent Chewings Red Fescue (*Festuca rubra* variety).
 - c. 15 percent Annual Rye Grass.
3. Shade: Proportioned by weight as follows:
 - a. 50 percent Chewings Red Fescue (*Festuca rubra* variety).
 - b. 35 percent Turf Type Fescue Blend.
 - c. 15 percent Annual Rye Grass.

2.04 TOPSOIL

- A. Topsoil - Lawns: ASTM D 5268, pH range of 5.5 to 7, a minimum of 3 percent organic material content; free of subsoil, clay lumps, gravel, stones, and other objects more than 1 inch in diameter in any dimension; and free of weeds, roots, and other deleterious materials harmful to plant growth. Topsoil shall contain less than 5% by volume of stones, rocks, and gravel.
 1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Where surface soils do not meet the requirements of section 2.04.A of this specification and/or where quantities of surface soils that do meet section 2.04.A of this specification are insufficient use imported or manufactured soils from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
- B. Topsoil - Meadows: Free of subsoil, clay lumps, gravel, stones, and other objects more than 3 inch in diameter in any dimension; and free of weeds, roots and other deleterious materials harmful to plant growth. Topsoil shall contain less than 10% by volume of stones, rocks, and gravel.
 1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

2.05 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 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.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- G. Sand: Clean, washed, natural or manufactured, free of toxic materials.
- H. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.06 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing 3/4 inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
- C. Wood Derivatives: Decomposed, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
- D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, or other bedding materials; free of toxic substances, stones, sticks, weed seed, and material harmful to plant growth.

2.07 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.08 FERTILIZER

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.09 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Peat Mulch: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
- C. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

- D. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- E. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- F. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.10 EROSION CONTROL MATERIALS

- A. Landlok® Erosion Control Blankets (ECB's) as manufactured by Propex, or approved equal, must be installed on all surfaces requiring seeding with slopes greater than or equal to 10% or in areas where grass cannot be established due to erosion. ECB's shall be selected and installed in accordance with manufacturer's recommendations.
- B. ECB's are not recommended in drainage channels. Rock riprap in accordance with details and specifications shall be used in drainage channels.
- C. Ground Anchoring Devices
 - 1. U-shaped wire staples or metal geotextile pins can be used to anchor blanket to the ground surface. Wire staples should be a minimum thickness of 8 gauge. Metal pins should be at least 0.20 in diameter steel with a 1-1/2 in steel washer at the head of the pin. Wire staples and metal pins should be driven flush to the soil surface. All anchors should be 6-18 in long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils. Heavier metal stakes may be required in rocky soils.
- D. Anchor Pattern Guide
 - 1. The shaded areas in the diagram shown in Propex's Installation Guidelines for ECB's provide anchor suggestions based on slope gradient and/or anticipated flow conditions. When the correct number of anchors has been evaluated, refer to the three illustrations in Propex's Installation Guidelines for ECB's to establish anchor pattern. Increased anchoring may be required depending upon site conditions.

PART 3 – EXECUTION

3.01 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.
- B. Verify the existence or non-existence of irrigation systems. Damaged systems shall be repaired with equipment to match existing and system tested for operation in an efficient and satisfactory manner. If damages to existing irrigation systems are incurred, the contractor shall be responsible for irrigation system repairs at the expense of the contractor.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, retaining walls, irrigation systems, and other facilities, trees, shrubs, and other plantings from damage caused by restoration operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding overspray.

- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 LAWN AND MEADOW RESTORATION

- A. Contractor shall maintain material storage areas throughout the project. Upon completion of the use of a material storage area, the Contractor shall be responsible for removal of all excess materials previously stored at the site. This shall include removing all traces of gravel bedding material from the storage area and restoring the location in accordance with this Specification.
- B. After the sanitary sewer infrastructure and electrical infrastructure have been installed and backfilled on any individual parcel, the Contractor shall have 15 days to perform initial cleanup, including debris removal, removal of stockpiled materials, tree materials (including root wads), subgrade preparation and grading. ASTM D2321 requires that the Contractor "backfill all trenches as soon as possible, but no later than the end of each working day." After a period of 45 days from installation and backfill of the infrastructure, the Contractor shall have completed testing and final cleanup and restoration on the parcel in accordance with the Details and Technical Specifications.
- C. All erosion caused by trenching/digging in an area shall be corrected withing 30 days of initial reports of such problems. This work is not considered final cleanup and will be included in the pipeline work and structure line items unit bid price. No pay request will be processed for any month during which this specification is not met until such time that cleanup is completed.
- D. Renovate existing lawns and meadows damaged by Contractor's operations including excavating, grading, clearing and grubbing, storage of materials and equipment, and movement of vehicles. Limit lawn and meadow subgrade preparation to areas to be planted.
- E. Measurement and payment for lawn and meadow restoration i.e. topsoil, seeding, fertilizing and mulching will be limited to disturbed areas within the permanent and temporary easement areas. Areas disturbed by construction activities outside these areas must be restored in accordance with these specifications but will be considered incidental and not paid for separately.
- F. Unchanged Subgrades: If lawns or meadows are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, such as material or equipment storage areas or areas where vehicles and equipment were driven then lawn or meadow renovation to be as follows:
 - 1. Remove unsatisfactory existing rocks, grass, vegetation, or turf. Do not mix into surface soil. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil droppings, fuel spills, stone, gravel, and other construction materials.
 - 2. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
 - 3. Raise subgrade to finish grade with topsoil.
 - 4. Loosen surface soil to a depth of at least of 6 inches. Remove stones larger than 1 inch in any dimension, sticks, roots, trash, and other extraneous matter.
 - 5. Apply soil amendments according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture. Remove any rock larger than 1 inch in any dimension, sticks, roots, trash, and other extraneous matter brought to the surface through tilling operations.
 - 6. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
 - 7. Apply fertilizer directly to surface soil per manufacturer's recommendations.
 - 8. Moisten prepared areas before planting if soil is dry. Do not create muddy soil.
 - 9. Apply seed per Section 3.04.

10. Install erosion control materials per Section 3.05, as required, to begin establishment of renovated area.
 11. Water newly planted areas and keep moist until new lawn or meadow is established.
 12. Legally dispose of all waste materials, including grass, vegetation, and turf, off Owner's property.
- G. Disturbed Subgrades: If lawns or meadows are to be planted in areas altered or disturbed by excavating, grading, or surface soil stripping operations, then lawn renovation to be as follows:
1. Backfill disturbed areas per project construction plans and details to within 4 inches of finish grade elevations. Remove unsatisfactory existing rocks, grass, vegetation, weeds, or turf. Do not mix into surface soil.
 2. Bring disturbed areas to finish grade using a minimum of 4 inches of topsoil. Remove stones larger than 1 inch in any dimension, sticks, roots, trash, and other extraneous matter.
 3. Apply soil amendments according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture. Remove any rock larger than 1 inch in any dimension, sticks, roots, trash, and other extraneous matter brought to the surface through tilling operations.
 4. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
 5. Apply fertilizer directly to surface soil per manufacturer's recommendations.
 6. Moisten prepared areas before planting if soil is dry. Do not create muddy soil.
 7. Apply seed per Section 3.04.
 8. Install erosion control materials per Section 3.05 as required to begin establishment of renovated area.
 9. Water newly planted areas and keep moist until new lawn or meadow is established.
 10. Legally dispose of all waste material, including grass, vegetation, and turf, off Owner's property.
- H. Meadow areas, while allowed to use onsite soils, will still be required to be seeded, fertilized and mulched in order to establish grass growth. A preparator or some other means or equipment shall be used to remove rocks larger than 4 inches and to clean areas where bedding material has been stored on the ground. If grass cannot be established by the end of the warranty period, Contractor will be required to bring in topsoil or other suitable soil approved by Engineer in order to facilitate grass growth.
- I. Restored areas are to be maintained for the duration of the project and during the one year maintenance period until a hardy stand of grass has been established. Areas eroded, washed out or otherwise disturbed during these periods must be reestablished.

3.04 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 lawn seed at the rate of 3 to 4 lb/1000 sq. ft. Meadow grasses to be sown at the rate noted in Section 2.02.
- C. Rake seed lightly into top 1/8 inch (3 mm) of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes greater than or equal to 10% with Landlock erosion-control blankets, or approved equal, as outlined in Section 3.05 of this specification. Erosion-control blankets shall be installed and stapled according to manufacturer's written instructions.

- E. Protect seeded areas with slopes not exceeding 10% by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches (38 mm) in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at the rate of 10 to 13 gal. /1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.05 EROSION CONTROL BLANKETS

- A. Site Preparation
 - 1. Grade and compact area of ECB installation as directed and approved by Engineer. Subgrade shall be uniform and smooth. Remove all rocks, clods, vegetation or other objects so the installed blanket will have direct contact with soil surface. Prepare seedbed by loosening the top 2-3 in (50-75 mm) minimum of soil. Incorporate amendments such as lime and fertilizer and/or wet the soil, if needed. Do not mulch areas where blanket is to be placed.
- B. Seeding
 - 1. Apply seed to soil surface before installing blanket. Disturbed areas shall be reseeded.
 - 2. Apply seed as specified in Section 3.04 of this specification.
- C. Installation on Soil Slopes
 - 1. Excavate a 12 x 6 in minimum longitudinal anchor trench 2-3 ft over crest of slope (see Figure 1 in Propex's Installation Guidelines for ECB's).
 - 2. Install top end of blanket into trench and secure to bottom of trench using ground anchoring devices spaced every 12 in minimum. Backfill and compact soil into trench.
 - 3. Verify correct side of ECB is facing ground. Unroll blanket down slope.
 - 4. Overlaps of adjacent rolls shall be 3 in minimum and anchor every 18 in minimum along the overlap. Secure using ground anchoring devices at the appropriate frequency and pattern shown below. Overlaps are shingled away from prevailing winds (see Figure 2 in Propex's Installation Guidelines for ECB's).
 - 5. Unroll blanket in a manner to maintain direct contact with soil. Do not pull blanket taut. Secure blanket to ground surface using anchoring devices.
 - 6. Excavate a 12 x 6 in minimum anchor trench at toe of slope (see Figure 3 in Propex's Installation Guidelines for ECB's).
 - 7. Install bottom end of blanket into trench and secure to bottom of trench using ground anchoring devices spaced every 12 in minimum. Backfill and compact soil in trench (see Figure 3 in Propex's Installation Guidelines for ECB's).
 - 8. Anchor blanket to the ground using U-shaped wire staples or metal geotextile pins. Wire staples should be a minimum thickness of 8 gauge. Metal pins should be at least 0.20 in diameter steel with a 1-1/2 in steel washer at the head of the pin. Wire staples and metal pins should be driven flush to the soil surface. All anchors should be 6-18 in long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils. Heavier metal stakes may be required in rocky soils.
 - 9. The shaded areas in the diagram shown in Propex's Installation Guidelines for ECB's provide anchor suggestions based on slope gradient and/or anticipated flow conditions. When the correct number of anchors has been evaluated, refer to the three illustrations in Propex's Installation Guidelines for ECB's to establish anchor pattern. Increased anchoring may be required depending upon site conditions.
 - 10. Irrigate as specified.

3.06 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with asphalt-emulsion tackifier.
 - 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.07 SODDING

- A. Sod shall be placed in areas where sod was pre-existing.
- B. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- C. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across angle of slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- D. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 4 inches below sod. Sod which dries out will be rejected.

3.08 SATISFACTORY LAWNS AND MEADOWS

- A. Satisfactory Seeded Lawn or Meadow: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Satisfactory Sodded Lawn or Meadow: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- C. Reestablish areas of lawns or meadows that do not comply with requirements and continue maintenance until areas are satisfactory.

3.09 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn or meadow renovation 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 grass is established.
- C. Remove erosion-control measures after grass establishment period.

END OF SECTION

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 SUMMARY

This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.02 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Cementitious materials and aggregates.
 - 2. Form materials and form-release agents.
 - 3. Steel reinforcement and reinforcement accessories.
 - 4. Fiber reinforcement.
 - 5. Admixtures.
 - 6. Waterstops.
 - 7. Curing materials.
 - 8. Floor and slab treatments.
 - 9. Bonding agents.
 - 10. Adhesives.
 - 11. Vapor retarders.
 - 12. Epoxy joint filler.
 - 13. Joint-filler strips.
 - 14. Repair materials.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- E. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixes.
 - c. Ready-mix concrete producer.
 - d. Concrete subcontractor.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Avoid damaging coatings on steel reinforcement.
- C. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963.

PART 2 – PRODUCTS

2.01 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints. Plywood, metal or other approved panel materials.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.
- G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface.
 2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.
 3. Furnish ties with integral welded waterstop collars to walls indicated to receive dampproofing, waterproofing, or that are otherwise required to be liquid tight.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 775, and Steel Reinforcement: ASTM A 615, Grade 60, deformed.
- C. Steel Bar Mats: ASTM A 184, assembled with clips. Steel Reinforcement: ASTM A 615, Grade 60, deformed bars.
- D. Plain-Steel Wire: ASTM A 82, as drawn.
- E. Deformed-Steel Wire: ASTM A 496.
- F. Epoxy-Coated Wire: ASTM A 884, Class A coated, plain-steel wire.
- G. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- H. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.
- I. Epoxy-Coated Welded Wire Fabric: ASTM A 884, Class A, plain steel.

2.03 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.
- C. Epoxy-Coated Joint Dowel Bars: ASTM A 775; with ASTM A 615, Grade 60, plain-steel bars.
- D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.

2.04 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
 - 1. Class: Severe weathering region, but not less than 3S.
 - 2. Nominal Maximum Aggregate Size: 1 inch.
 - 3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 sieve, and less than 8 percent may be retained on sieves finer than No. 50.
- C. Lightweight Aggregate: ASTM C 330 with nominal Maximum Aggregate Size of 1 inch.

- D. Water: Potable and complying with ASTM C 94.

2.05 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.06 FIBER REINFORCEMENT

- A. Synthetic Fiber: Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
- B. Products: Subject to compliance with requirements, provide one of the following Monofilament Fibers:
 - 1. Fibrasol IIP; Axim Concrete Technologies.
 - 2. Fiberstrand 100; Euclid Chemical Co.
 - 3. Fibermix Stealth; Fibermesh, Div. of Synthetic Industries.
 - 4. Forta Mono; Forta Corporation.
 - 5. Grace MicroFiber; W. R. Grace & Co., Construction Products Div.
 - 6. Hi-Tech PPM Fiber; Hi-Tech Fibers, Div. of Martin Color-Fi, Inc.
 - 7. Polystrand 1000; Metalcrete Industries.

2.07 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. As indicated in Profile.
- B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. As indicated in Profile.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following rubber waterstops:
 - 1. Rubber Waterstops:
 - a. Greenstreak.
 - b. Progress Unlimited Inc.
 - c. Wstec Barrier Technologies; Div. of Western Textile Products, Inc.
 - d. Williams Products, Inc.
 - 2. PVC Waterstops:
 - a. Greenstreak.
 - b. Meadows: W. R. Meadows, Inc.
 - c. Murphy: Paul Murphy Plastics Co.
 - d. Progress Unlimited Inc.
 - e. Sternson Group.

- f. Tamms Industries Co.; Div. of LaPorte Construction Chemicals North America, Inc.
 - g. Vinylex Corporation.
 - h. Westec Barrier Technologies; Div. of Western Textile Products, Inc.
- D. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete. Products are subject to comply with requirements. Provide one of the following:
 - 1. Volclay Waterstop-RX; Colloid Environmental Technologies Co.
 - 2. Conseal CS-231; Concrete Sealants Inc.
 - 3. Swellseal Joint; De Neef Construction Chemicals (U.S.) Inc.
 - 4. Hydrotite; Greenstreak.
 - 5. Mirastop; Mirafi Moisture Protection, Div. of Royal Ten Cate (USA), Inc.
 - 6. Adeka Ultra Seal; Mitsubishi International Corporation.
 - 7. Superstop; Progress Unlimited Inc.

2.08 VAPOR RETARDERS

- A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials:
 - 1. Polyethylene sheet, ASTM D 4397, not less than 10 mils thick:
 - 2. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils thick.
- B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.
- C. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.09 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Solvent-Borne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.10 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Epoxy Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.
- C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:

1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.11 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
 2. Proportion lightweight structural concrete according to ACI 211.2 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Proportion normal-weight concrete mix as follows:
 1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum Slump: 4 inches.
 3. Maximum Slump for Concrete Containing High-Range Water-Reducing Admixture: 8 inches after admixture is added to concrete with 2- to 4-inch slump.
 4. Minimum Cementitious Materials Content: 540 lb/cu. yd.
- D. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements.
- E. Maximum Water-Cementitious Materials Ratio: 0.40.
- F. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated. Air content is to be 6 percent.
- G. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.
- H. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- I. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
- J. Admixtures: Use admixtures according to manufacturers written instructions.
 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.12 FABRICATING REINFORCEMENT

Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

PART 3 – EXECUTION

3.01 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch.
 - 2. Class B, 1/4 inch.
 - 3. Class C, 1/2 inch.
 - 4. Class D, 1 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Install anchor bolts, accurately located, to elevations required.
- C. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
- D. Install dovetail anchor slots in concrete structures as indicated.

3.03 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
 - 1. At least 70 percent of 28-day design compressive strength.
 - 2. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
 - 3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.04 SHORES AND RESHORES

- A. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.05 VAPOR RETARDERS

- A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

- B. Fine-Graded Granular Material: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
- C. Granular Fill: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch. Place and compact a 1/2-inch- thick layer of fine-graded granular material over granular fill.

3.06 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963.

3.07 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.08 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.

3.09 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Limit dropping height of concrete in forms to 60 inches or less. Place each layer while preceding layer is still plastic, to avoid cold joints.
1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Break back form tie ends below the concrete surface and clean and patch tie hole recesses to full depth. Repair and patch defective areas. Remove fins and other projections exceeding 1/8 inch in height. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
 - 2. Finish and measure surface so gap at any point between concrete surface and an unlevelled freestanding 10-foot- long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 1/4 inch.
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- G. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
 - 1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
 - 2. After broadcasting and tamping, apply float finish.
 - 3. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Concrete surfaces exposed to wastewater:
 - a. Break back form-tie voids shall be cleaned and patched by a non-shrink cementitious grout, shrinkage compensating grout, or an approved epoxy repair system.
 - b. Form ties that are fully removed and leave a void through the wall, such as taper ties, shall only be repaired with a manufactured sealing system made for that purpose, subject to Engineer's approval.
 - 3. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 4. Repair defects on concealed-formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
 - 5. Concrete surface repairs shall be subject to inspection for conformance with this Specification. Form ties left flush to the surface or protruding from the surface are non-conforming. All surface repairs and patches are to be subject to inspection prior to backfill of the structure. All corrections to non-conforming surface repairs or patches shall be at the Contractor's expense.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.16 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of four standard cylinder specimens for each composite sample. Cast and field cure one set of four standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

- D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- E. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.

END OF SECTION

SECTION 0550 – METAL FABRICATIONS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Ladders.
 - 2. Loose bearing and leveling plates.
 - 3. Shelf angles.
 - 4. Miscellaneous metal trim.
 - 5. Metal floor plate.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Nonslip aggregates and nonslip-aggregate surface finishes.
 - 2. Extruded nosings and treads.
 - 3. Paint products.
 - 4. Grout.
- B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 1. Provide templates for anchors and bolts specified for installation under other Sections.
- C. Samples for Verification: For each type and finish of extruded nosing and tread.

1.04 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.06 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 – PRODUCTS

2.01 METALS, GENERAL

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
- C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- D. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.
- E. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.03 ALUMINUM

- A. Aluminum Extrusions: ASTM B 221, alloy 6063-T6.
- B. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, alloy 6061-T6.

2.04 FASTENERS

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

2.05 GROUT

- A. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 CONCRETE FILL

- A. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in- Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.07 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- I. Remove sharp or rough areas on exposed traffic surfaces.
- J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.08 LADDERS

- A. General: Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.
 - 1. Comply with ANSI A14.3, unless otherwise indicated.
- B. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.
- C. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted aluminum brackets. Size brackets to support design loads specified in ANSI A14.3. Hold ladder clear of wall a minimum of 7 inches from wall to centerline of rungs. If adjacent structure does not extend above the top run, goose-neck the extended rails back to the structure to provide secure ladder access.
- D. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.

2.09 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates after fabrication.

2.10 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
- B. Galvanize shelf angles to be installed in exterior walls.
- C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.11 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches o.c., unless otherwise indicated. Galvanize miscellaneous steel trim located in any exterior location. Delete paragraph below if no trim is galvanized.

2.12 METAL FLOOR PLATE

- A. Fabricate raised-pattern floor plates from rolled-aluminum-alloy tread plate of thickness indicated below:
 - 1. Thickness: As indicated.
- B. Abrasive-Surface Floor Plate: Fabricate from steel plate, of thickness indicated below, with abrasive granules rolled into surface. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C 1028.
- C. Include aluminum angle stiffeners, and fixed and removable sections as indicated.

2.13 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications.

2.14 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

PART 3 – EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.02 SETTING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.

3.03 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 07160 – BITUMINOUS DAMPPROOFING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of each type of dampproofing work is indicated on drawings and as follows:
 - 1. Manholes, all types and locations.
 - 2. Valve Vaults.
 - 3. All underground tanks.
 - 4. Similar work used as exposed finish is excluded by definition and, if required, is specified as waterproofing, vapor barrier, roofing, flooring, special coating or other appropriate category.
- B. This Section includes the following:
 - 1. Cold-applied, cut-back asphalt dampproofing.

1.02 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data: Submit manufacturer's technical product data, installation instructions, and recommendations for each dampproofing material required. Include data substantiating that materials comply with requirements.
- C. Certifications: Submit manufacturer's certification in writing that the product is suitable for the application specified. Certification letter shall state the required application rate to dampproof the indicated structures.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record (not less than three years) of successful in-service performance. The Installer must be acceptable to manufacturer of primary materials.
- B. Single-Source Responsibility: Obtain primary dampproofing materials and primers from one source and by a single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

1.04 PROJECT CONDITIONS

- A. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.
- B. Weather Limitations: Proceed with dampproofing only when existing and forecasted weather conditions will permit work to be performed according to manufacturer's recommendations and warranty requirements.
- C. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

PART 2 – PRODUCTS

2.01 BITUMINOUS DAMPPROOFING MATERIALS (BIT-DP)

- A. General: Provide bituminous dampproofing materials that comply with the following requirements, or provide other similar products that are certified in writing by manufacturer of primary dampproofing materials to be superior in performance for application indicated.
- B. Manufacturer: Subject to compliance with requirements, provide coal-tar products of one of the following:
 - 1. Celotex Corporation
 - 2. GAF Corporation
 - 3. Koppers Company, Inc.
 - 4. Or approved equal

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine Substrate and conditions under which dampproofing work is to be performed and notify Contractor in writing of unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

- A. Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.
- B. Install cant strips and similar accessories as shown and as recommended by prime materials manufacturer even though not shown.
- C. Fill voids, seal joints, and apply bond breakers, if any, as recommended by prime materials manufacturer, with particular attention at construction joints.
- D. Install separate flashings and corner protection stripping, as recommended by prime materials manufacturer, where indicated to precede application of dampproofing. Comply with details shown and with manufacturer's recommendations. Pay particular attention to requirements at building expansion joints, if any.
- E. Prime substrate as recommended by prime materials manufacturer.
- F. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

3.03 INSTALLATION

- A. Comply with manufacturer's recommendations except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of work.

- B. Cold Bitumen on Exterior Surfaces:
 - 1. Apply a coat of cold, semi-fibrated, semi-mastic asphalt dampproofing material, by brushing or spraying at rate certified by manufacturer to produce uniform dry film thickness of not less than 30 mils.
- C. Dampproof Protection Course:
 - 1. General: Where indicated, install protection course of type indicated, over completed-and-cured dampproofing treatment. Comply with dampproofing materials manufacturer's recommendations for method of support or attachment of protection materials. Support with spot-application of plastic cement where not otherwise indicated.

END OF SECTION

SECTION 07200 – PROTECTIVE COATING FOR CONCRETE SANITARY SEWER STRUCTURES

PART 1 – GENERAL

1.01 SUMMARY

- A. This specification covers work, materials and equipment required for protecting and/or rehabilitating concrete structures by spray-application of a monolithic high-build epoxy coating to eliminate infiltration, provide corrosion protection, repair voids and enhance structural integrity. Procedures for surface preparation, cleaning, application and testing are described herein.

1.02 SECTION INCLUDES

- A. Requirements for surface preparation, repairs and solvent-free epoxy coating application to specified surfaces.

1.03 RELATED SECTIONS

- A. Concrete Repair.
- B. Environmental, Health and Safety.

1.04 REFERENCES

- A. ASTM D638 - Tensile Properties of Plastics.
- B. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 - Compressive Properties of Rigid Plastics.
- D. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.
- E. ASTM D2584 - Volatile Matter Content.
- F. ASTM D2240 - Durometer Hardness, Type D.
- G. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- H. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
- I. ASTM C396 - Compressive Strength of Cement Mortars.
- J. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
- K. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- L. ASTM D4258 - Standard Practice for Surface Cleaning Concrete
- M. ASTM D4259 - Standard Practice for Abrading Concrete
- N. ASTM D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

- O. ASTM D7234 - Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
- P. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
- Q. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- R. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.

1.05 SUBMITTALS

- A. The following items shall be submitted:
 - 1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
 - 2. Material Safety Data Sheets (MSDS) for each product used.
 - 3. Project specific guidelines and recommendations.
 - 4. Applicator Qualifications:
 - a. Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.
 - b. Certification by the protective coating manufacturer that the equipment to be used for applying the products has been approved and Applicator personnel have been trained and certified for proper use of the equipment.
 - c. Proof of any necessary federal, state or local permits or licenses necessary for the project.
 - 5. Design details for any additional ancillary systems and equipment to be used in site and surface preparation, application and testing.

Or Equal Submittal: In order to be considered as an equal product, said product will have to meet the minimum characteristics as measured by the applicable ASTM standards referenced in paragraph 2.04 and on the Technical Data Sheets of the approved products.

Note: Equal products must be approved a minimum of three weeks prior to bid date. In order for a product to be considered equal the submitted product must have successfully passed the Los Angeles County evaluation of protective coatings for concrete or the product must be tested and meet or exceed the minimum standards included in this specification. A bonded third party testing company must perform the testing. A contractor that has been licensed and trained by the manufacturer must install all products.

Prior pre-approval is required to determine if the prospective product may be bid on this project. Without prior pre-approval within the specified time frame a product may be rejected as unacceptable. This time frame allows the Engineer ample time to determine if the proposed product is an acceptable alternative.

1.06 QUALITY ASSURANCE

- A. Coating and repair products shall be capable of being installed and curing properly within the specified environments; specifically, within environmental conditions of a typical sanitary sewer. Coating products shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems.
- B. Coating and repair products shall be fully compatible; including ability to bond effectively (as tested for in Section 3.06.C.) to each other and/or the host substrate, forming a composite system.

- C. Applicator shall utilize equipment for the application of the coating and repair products which has been approved by the product manufacturer; and Applicator shall have received training on the operation and maintenance of said equipment from the product manufacturer. Written certification of such approvals and training shall be submitted by the coating and repair product manufacturers.
- D. Applicator and applicator personnel shall be certified by, or have their training approved and certified by, the coating and repair product manufacturers for the handling, mixing, application, and inspection of the products to be used as specified herein. Written certification of such training shall be submitted by the coating and repair product manufacturers and shall include the individual applicator personnel to be employed on the project.
- E. Inspectors shall be AMPP CIP Level 2 and on site for pre-construction meetings and the following hold points:
 - 1. Initial surface preparation and resurfacing
 - 2. Initial application
 - 3. Initial holiday detection testingOwner will determine other inspections based on progress and results. Inspectors must be knowledgeable of the proper use, preparation, and installation of the products to be used as specified herein.
- F. Applicator shall initiate and enforce quality control procedures consistent with the coating product manufacturer's recommendations and applicable ASTM, NACE, SSPC, ICRI, or other standards as referenced herein.
- G. Pre-construction meeting shall take place no less than two weeks prior to Applicator mobilization. All parties to have physical presence on the project during construction shall be present. At this meeting responsibilities and authorities during construction shall be discerned; comments and questions regarding materials and execution of the specifications shall be presented and addressed.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Materials are to be kept dry, protected from weather and stored under cover.
- B. Protective coating materials are to be stored between 50°F and 90°F. Do not store near flame, heat or strong oxidants.
- C. Protective coating materials are to be handled according to their material safety data sheets.

1.08 SITE CONDITIONS

- A. Applicator shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- B. Method statements and design procedures are to be provided by the Applicator to the Owner when confined space entry, flow diversion, debris removal or bypass is necessary in order for Applicator to perform the specified work.

1.09 WARRANTY

- A. Applicator shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Applicator shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.

- B. Coating and repair product supplier(s) shall warrant all coating materials for a period of one (1) year from the date of final acceptance, unless otherwise noted, to be free of manufacturing defects; and products will meet current published physical properties when applied and tested in accordance with the manufacturer's standards. If, within said one (1) year period, any product does not meet the physical properties or is defective in manufacturing, the manufacturer will either replace the defective product or refund the purchase price to the Applicator.

PART 2 – PRODUCTS

2.01 EXISTING PRODUCT

- A. Standard Portland cement or new concrete (not quick setting high strength cement) must be well cured prior to application of the protective coating. Generally, 28 days is adequate cure time for standard Portland concrete. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself.)
- B. Cementitious patching and repair materials should not be used unless their manufacturer provides information as to its suitability for top coating with an epoxy coating. Project specific submittals and procedures should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the epoxy coating.
- C. Remove existing coatings prior to application of the new protective coating. Applicator is to maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation and compatibility with existing coatings.

2.02 MANUFACTURER

- A. Corrosion Protective Coating: Raven Lining Systems, Inc., Tulsa, Oklahoma 800-324-2810 or 918-584-2810 or FAX 918-582-4311.
- B. Cementitious Repair Material: Raven Lining Systems, Inc., Tulsa, Oklahoma 800-324-2810 or 918-584-2810 or FAX 918-582-4311.
- C. Or Pre-approved Equal

2.03 REPAIR MATERIALS

- A. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the engineer and protective coating applicator. Repair materials must be compatible with the specified epoxy coating and shall be applied in accordance with the manufacturer's recommendations.
 - 1. Repair materials must be supplied by the coating product manufacturer or be an approved equal product.
 - 2. For a product to be considered an approved equal, the submitted product must meet or exceed the minimum characteristics as measured by the applicable standards referenced herein and on the Technical Data Sheets of the approved products. Submitted products must also be expressly approved by the coating product manufacturer in writing for compatibility with the specified coating product.
 - 3. All materials shall be mixed, applied, and cured in accordance with the manufacturer's recommendations.

4. Repair product physical properties shall be substantiated through submittal of accredited third-party testing results and shall be representative of the actual field applied product and cure mechanisms to be employed in the field.
- B. Hydraulic cements to be used for the remediation of low-volume infiltration.
 1. Manufacturer: As applicable
 2. Product: Hydraulic cements as appropriate for infiltration.
- C. Hydrophobic or Hydrophilic injectable chemical grout to be used for remediation of high-volume infiltration or crack repair and/or soil stabilization and void filling.
 1. Manufacturer: As applicable
 2. Product: Chemical grout as appropriate for infiltration, crack repair, and soil stabilization.
- D. Skim coat, Option 1: Factory blended, high performance polymer cement repair mortar to be spray, trowel, or otherwise manually applied to the entire surface.
 1. Manufacturer: Raven Lining Systems, 800-324-2810
 2. Product: Raven 760 HPPC – Polymer Cement Mortar having the following characteristics:

Product Type:	Polymer Cement Mortar
Tensile Strength	700 psi
Compressive Strength	>5,120 psi @ 28 days
Compressive Strength	>5,210 psi @ 28 days
Flexural Strength	>1,240 psi
Shrinkage @ 90% R.H.	0%
Adhesion to Concrete	>200 psi
- E. Skim coat, Option 2: 100% solids, solvent-free, ultra-high build epoxy coating to be trowel or otherwise manually applied to interior surfaces of exposed concrete for the purpose of filling small surface abnormalities and rough profiles exceeding CSP 8. Raven 405 trowel can be applied with or without the addition of the component part C for a standalone coating or a glaze coat application.
 1. Manufacturer: Raven Lining Systems, 800-234-2810
 2. Product: Raven 405 Trowel – 100% solids, three component solvent-free ultra-high-build epoxy system having the following characteristics:

Product Type:	Amine cured epoxy
VOC Content	0%
Compressive Strength	>11,200 psi
Compressive Strength without part C	>18,600 psi
Tensile Strength	>4,000 psi
Tensile Strength without part C	>4,900 psi
Flexural Modulus	>806,000 psi
Flexural Modulus without part C	>810,000 psi
Adhesion to Concrete	>200 psi with substrate (concrete) failure
Chemical Resistance (ASTM D543/G20) immersion service for:	
Municipal sanitary sewer environment	
Sulfuric Acid	50%
Sodium Hydroxide	10%
Sodium Hypochlorite	3%
- F. Resurfacer, Option 1: Factory blended, rapid setting, high-early strength, non-shrink, Portland cementitious repair mortar to be trowel or pneumatically spray applied to the entire surface.
 1. Manufacturer: Raven Lining Systems, 800-324-2810
 2. Product: Raven 755 – Cement Mortar having the following characteristics:

Product Type:	Portland cement mortar
Tensile Strength	>800 psi
Compressive Strength	>9,000 psi @ 28 days

Flexural Strength	>1,500 psi
Shrinkage @ 90% R.H.	0%
Adhesion to Concrete	>2,000 psi
Freeze/Thaw	100 Cycles, no visible damage

- G. Resurfacer, Option 2: Factory blended, rapid setting, high-early strength, non-shrink, calcium aluminate repair mortar to be trowel or pneumatically spray applied to the entire surface.
1. Manufacturer: Raven Lining Systems, 800-324-2810
 2. Product: Raven 705CA – Cement Mortar having the following characteristics:

Product Type:	Calcium aluminate mortar
Tensile Strength	>685 psi
Compressive Strength	>9,200 psi @ 28 days
Flexural Strength	>1,650 psi
Shrinkage @ 90% R.H.	0%
Adhesion to Concrete	>4,000 psi
Freeze/Thaw	100 Cycles, no visible damage
Density of wet mix:	129-139 lbs./ft ³
Applied Density:	135 lbs/ft ³ (±5 lbs./ft ³)

2.04 PROTECTIVE COATING MATERIAL

- A. A 100% solids, solvent-free, ultra-high build epoxy coating to be spray applied to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.
1. Manufacturer: Raven Lining Systems, 800-324-2810
 2. Product: Raven 405 series (405,) – 100% solids, solvent-free ultra-high build epoxy system exhibiting the following characteristics:

Product type	Amine cured epoxy
VOC Content	0%
Flexural Modulus	727,000 psi
Compressive Strength	18,000 psi
Tensile Strength	9,000 psi
Adhesion to Concrete	>200 psi with substrate (concrete) failure
Chemical Resistance (ASTM D543/G20) immersion service for:	
Municipal sanitary sewer environment	
Sulfuric Acid	50%
Sodium Hydroxide	10%
Sodium Hypochlorite	3%

Successful Pass: Sanitation District of L.A. County Coating Evaluation Study and SSPWC 210.2.3.3 (Greenbook "Pickle Jar" Chemical Resistance test)

2.05 PROTECTIVE COATING APPLICATION EQUIPMENT

- A. Manufacturer heated plural component spray equipment shall be used in the application of the specified protective coating.
- B. Coating product application to hard to reach areas or for touch-ups may be performed using hand tools.

2.06 REPAIR MORTAR SPRAY APPLICATION EQUIPMENT (if spray applied)

- A. Spray applied repair mortars shall be applied with manufacturer approved equipment.
- B. Cementitious repair products to be spray applied shall be mixed and applied using manufacturer approved batch mixing and low velocity spray devices.

PART 3 – EXECUTION

3.01 ACCEPTABLE APPLICATORS

- A. Repair mortar applicators shall be trained to properly apply the cementitious mortar according to manufacturer's recommendations.
- B. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer specifications.

3.02 EXAMINATION

- A. All structures to be coated shall be readily accessible to Applicator.
- B. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.
- C. New Portland cement concrete structures shall have a minimum 28 days cure since manufacture prior to commencing coating installation. Should earlier coating be required, coating product manufacturer shall recommend specifications including appropriate cure assessment testing or use of specialty primers and sealers (Raven 155, 171, 175 primers).
- D. Any active flows shall be dammed, plugged or diverted as required to ensure that the liquid flow is maintained below or away from the surfaces to be coated until final applications are cured as recommended by the manufacturer.
- E. Installation of the protective coating shall not commence until the concrete substrate has properly cured and been prepared in accordance with these specifications.
- F. Temperature of the surface to be coated should be maintained between 40°F and 120°F during application.
- G. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the surface temperature is falling versus rising (ie. late afternoon into evening as opposed to morning into afternoon).

3.03 SURFACE PREPARATION

- A. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.
- B. Excessive debris, sediment, root intrusion, or other foreign materials which may impact the effectiveness of the surface preparation process shall be removed prior to the commencement thereof.
- C. Offset structural components, lids, covers, frames, etc. shall be repaired, replaced, or reset prior to the commencement of surface preparation.
- D. External soil/fill voids shall be remediated and/or stabilized by replacement or injection of stabilizing grout as determined appropriate by the Engineer.

- E. All contaminants including: oils, grease, unsound or incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed in accordance with SSPC-SP-1 – Solvent Cleaning.
- F. All concrete that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.
- G. Surface preparation method(s) should be based upon the conditions of the substrate and the requirements of the epoxy protective coating to be applied.
- H. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound concrete surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. Generally, this can be achieved with a low pressure water cleaning using equipment capable of 5,000 psi at 5 gpm, using a zero degree rotating nozzle. Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be used. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound clean neutralized surface that is not excessively damaged.
- I. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for top coating with the specified epoxy protective coating.
- J. Test prepared surfaces after cleaning but prior to application of the epoxy coating to determine if a specific pH or moisture content of the concrete is required according to manufacturer's recommendations.
- K. All surfaces should be inspected during surface prep and before the repair mortar is applied.
- L. Areas where structural steel has been exposed or removed shall be repaired in accordance with the Project Engineer's recommendations.

3.04 APPLICATION OF REPAIR MATERIALS

- A. Repair materials shall meet the specifications contained herein. The materials shall be trowel or spray applied utilizing proper equipment on to specified surfaces. The material thickness shall be in accordance with the Owner's requirements and manufacturer's recommendations.
- B. Cementitious repair materials shall be trowelled to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bug holes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar.
- C. The repair materials shall be permitted to cure according to manufacturer recommendations.
- D. Application of the repair materials, if not performed by the coating certified applicator, should be inspected by the protective coating manufacturer's representative or certified applicator to ensure proper finishing for suitability to receive the specified coating.
- E. After abrasive blast and leak repairs have been performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shotblast or other approved method. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the epoxy coating.

- F. All surfaces should be inspected during and after preparation and before the protective coating is applied.

3.05 APPLICATION OF PROTECTIVE COATING

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.
- C. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.
- D. Specified surfaces shall be coated by spray application of a moisture tolerant, solvent-free, 100% solids, epoxy protective coating as further described herein. Spray application shall be to the following minimum dry film thicknesses:

Concrete, New/Smooth: The coating shall be applied at 80 to 100 mils minimum dry film thickness applied to surface with profiles of CSP-3 to CSP-5 maximum.

Condition 1 (Low-rehabilitation structures): The coating shall be applied at 100 to 125 mils minimum dry film thickness to surface profiles of CSP-3 to CSP-5 maximum.

Condition 2 (Mild rehabilitation structures): The coating shall be applied at 125 to 150 mils minimum dry film thickness to surface profiles of CSP-3 to CSP-5 maximum.

Condition 3 (Severe-rehabilitation structures): The coating shall be applied at 150 to 250 mils minimum dry film thickness to surface profiles of CSP-3 to CSP-5 maximum.

(Thicknesses shown above are for general purposes only, each project should be evaluated independently and thickness of system determined upon product, service environment, protection and restoration requirements.)

See coating manufacturer for mil thickness recommendations to resist ground water head pressure.

- E. Airless spray application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating. Air assisted spray application equipment may be acceptable, especially for thinner coats (<10 mils), only if the air source is filtered to completely remove all oil and water.
- F. If necessary, subsequent top coating or additional coats of the protective coating shall occur within the product's recoat window. Additional surface preparation procedures will be required if this recoat window is exceeded.
- G. (Optional) Fiberglass woven-roving fabric may be rolled into the resin or chopped glass spray applied with the resin for added tensile and flexural strength where desired, such as the crown of pipes. Sloped surfaces of the floor may be made non-skid by broadcasting aluminum oxide or silica sand into the surface prior to gelation.
- H. Coating products shall interface with adjoining construction materials/components throughout the structure to effectively seal and protect substrates from attack by corrosive elements and to ensure the effective elimination of infiltration into the sewer system.

- I. Procedures and materials necessary to affect the interface between dissimilar materials and the coating product shall be as recommended by the coating product manufacturer.
- J. Termination points of the coating product shall be at the structure frame and chimney joint (or other man way as is present), one inch (1") below normal flow levels at the bench or within the invert, unless invert is specified to receive coating, and a minimum of one inch (1") interfacing within each pipe penetration.

3.06 TESTING AND INSPECTION

- A. Coating system thickness shall be inspected to ensure compliance with the specifications herein.
 - 1. During application a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application. Measurements shall be taken, documented, and attested to by Applicator for submission to Owner.
 - 2. After the coating products have cured in accordance with manufacturer recommendations, coating system thickness may be measured according to SSPC-PA-9 – Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages.
- B. High voltage holiday detection for coating systems installed in corrosive environments, when it can be safely and effectively employed, shall be performed to ensure monolithic protection of the substrate. After the coating products have cured in accordance with manufacturer recommendations, all surfaces shall be inspected for holidays in accordance with NACE SPO 188-2006-SG Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates or ASTM D4787 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates. All detected holidays shall be marked and repaired according to the coating product manufacturer's recommendations.
 - 1. Test voltage shall be a minimum of 100 volts per mil of coating system thickness.
 - 2. Detection of a known or induced holiday in the coating product shall be confirmed to ensure proper operation of the test unit.
 - 3. All areas repaired shall be retested following cure of the repair materials.
 - 4. In instances where high voltage holiday detection is not feasible, a close visual inspection shall be conducted, and all possible holidays shall be marked and repaired as described above.
 - 5. Documentation of areas tested, equipment employed, results, and repairs made shall be submitted to the Owner/Engineer by Applicator.
- C. Adhesion of the coating system to the substrate shall be confirmed in a minimum of 10% of the manholes coated, or for large structures once every 1,000 square feet of coated area. After the coating products have cured in accordance with manufacturer recommendations, testing shall be conducted in accordance with ASTM D7234 Pull-Off Adhesion Testers. Owner's representative shall select the areas to be tested.
 - 1. For each test manhole a minimum of three 20 mm dollies shall be affixed to the coated surface; one at the cone area, one at the mid-section, and one near the bottom of the structure.
 - 2. For larger structures a minimum of three 20 mm dollies shall be affixed to the coated surface at random locations within each 1,000 square foot area or as otherwise agreed upon.
 - 3. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths more than at least twice the anticipated failure point (generally 1,000 psi) and permitted to cure in accordance with manufacturer recommendations. The coating and dollies shall be adequately cleaned and prepared to receive the adhesive. Failure of the dolly adhesive shall be deemed a non-test and require retesting.
 - 4. Prior to performing the pull test, the coating shall be scored to the substrate, or within 10 mils of the substrate surface, by mechanical means with disturbing the dolly or coating system bond within the test area.

5. Two of the three adhesion pulls in each test area shall exceed 200 psi and shall include substrate adhered to the back of the dolly or no visual signs of the coating product in the test hole. Pull tests with results between 150 and 200 psi may be acceptable if more than 50% of the substrate in the test area is adhered to the dolly.
 6. Should a structure, or area, fail to achieve two successful pulls as described above, additional testing shall be performed at the discretion of the Owner or Project Engineer. Any areas detected to have inadequate bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Applicator.
 7. All adhesion testing shall be performed by qualified personnel using calibrated equipment as specified by the applicable ASTM standards.
 8. All adhesion testing shall be documented and submitted in a consistent format detailing location, test values, description of failure point/mode, scoring method employed, adhesive used, cure time of coating and adhesive, and other data as deemed necessary by the Owner/Engineer.
 9. All adhesion test locations shall be repaired by the Applicator at no cost to the Owner.
- D. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating affecting the performance of the coating system or the operational functionality of the structure shall be marked and repaired according to the procedures set forth herein by Applicator.
- E. The municipal sewer system may returned to non-severe operational service as soon as the final inspection has taken place. However, for severe corrosion duty such as high concentrations of acids, bases or solvents, 3 to 7 days and/or force cure by heat induction to the coated surfaces may be necessary prior to returning to service. Consult coating manufacturer for further details.

END OF SECTION

SECTION 07900 – JOINT SEALERS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. The extent of each form and type of joint sealer is indicated on drawings and by provisions of this section.
- B. The applications for joint sealers as work of this section include the following:
 - 1. Pavement and sidewalk joints.
 - 2. Concrete construction joints where indicated on the drawings.
 - 3. Concrete and masonry control joints.
 - 4. Door frames to masonry joints.
 - 5. Floor joints (interior).
 - 6. Wall joints (exterior).
 - 7. Flashing and coping joints.
 - 8. Gasketing of assemblies.

1.02 SYSTEM PERFORMANCES

- A. Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.
- B. Provide joint sealers that have been recommended by the manufacturer for service under the conditions of the particular joint application, including but not limited to exterior exposure, thermal or other movement, abrasion, or submergence.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each joint sealer product required, including instructions for joint preparation and joint sealer application.
- B. Product Certification: Submit certification in writing by the sealant manufacturer that each sealer product is recommended and suitable for the proposed application. The written certification shall name the sealer product and shall identify the specific structures and locations where the sealer will be installed.
- C. Product Tests: If required by the Engineer, submit certified test reports for elastomeric sealants on aged performances as specified, including hardness, stain resistance, adhesion, cohesion or tensile strength, elongation, low- temperature flexibility, compression set, modulus of elasticity, water absorption, and resistance (aging, weight loss, deterioration) to heat and exposure to ozone and ultraviolet.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.
- B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. General: Manufacturers listed in this article include those known to produce the indicated category of prime joint sealer material, either as a nominally pure generic product or as an equivalent-performance modification thereof or proprietary product.
- B. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Manufacturers of Elastomeric Sealants (Liquid):
 - a. Dow Corning Corp.; Midland, MI
 - b. General Electric Co.; Waterford, NY
 - c. Gibson-Homans Co.; Waterford, NY
 - d. W.R. Meadows, Inc.; Elgin, IL
 - e. Pecora Corp.; Harleysville, PA
 - f. Sika Chemical Corp.; Lindhurst, NJ
 - g. Sonneborn, A Division of Rexnord; Minneapolis, MN
 - h. Tremco, Inc.; Cleveland, OH
 - i. Woodmont Products Inc.; Huntingdon Valley, PA
 - j. Or approved equal.
 - 2. Manufacturers of Joint Fillers/Sealant Backers:
 - a. Dow Chemical Co.; Midland, MI
 - b. Hercules, Inc.; Middletown, DE
 - c. W.R. Meadows, Inc.; Elgin, IL
 - d. Sonneborn, A Division of Rexnord, Minneapolis, MN
 - e. Woodmont Products, Inc.; Huntingdon Valley, PA
 - f. Or approved equal.

2.02 MATERIALS

- A. General Sealer Requirements: Provide colors indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated, select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated. Where exposed to foot traffic, select non-tracking materials of sufficient strength and hardness to withstand stiletto heel traffic without damage or deterioration of sealer system.
- B. Elastomeric Sealants:
 - 1. Single-Component Polyurethane Sealant (1Pu-S): Except as otherwise indicated, provide manufacturer's standard, non-modified, one-part, polyurethane-based, air-curing, elastomeric sealant; complying with either ASTM C 920 type S Class 25, or FS TT-S-00230C Class A; self-leveling grade/type where used in joints of surfaces subject to traffic, otherwise non-sag grade/type. For use in all horizontal paving control joints. Bituminous Modification (-Bit): Where joint surfaces contain or are contaminated with bituminous materials, provide manufacturer's modified type sealant that is compatible with joint surfaces (modified with coal tar or asphalt as required).
 - 2. Single-Component Silicon Rubber Sealant (1SR-S): Except as otherwise indicated, provide manufacturer's standard, non-modified, one-part, silicone-rubber-based, air-curing, non-sag, elastomeric sealant; complying with either ASTM C 920 Type S Class 25 Grade NS, or FS TT-S-001543A Class A Type S Non-sag. For use in all vertical control joints in masonry, flashing and door frames.
- C. Joint Fillers, Pavement Types:
 - 1. Expanded Polyethylene Joint Filler (ExPe-JF): Provide flexible, compressible, closed-cell, polyethylene of not less than 10 psi compression deflection (25%); except provide higher

compression deflection strength as may be necessary to withstand installation forces and provide proper support for sealants; surface water absorption of not more than 0.1 lbs. per sq. ft.

2. Open-Cell Polyurethane Joint Filler (OcPu-JF): Provide flexible, highly compressible, open-cell polyurethane foam of not less than 1.3 lbs. per cu. ft. density and not less than 2 psi compression deflection (25%), with not more than 10% compression set for 25 hours at 50% compression (ASTM D 3574 test methods).

D. Miscellaneous Materials

1. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.
2. Bond Breaker Tape (BB-Tp): Provide polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant- contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.
3. Sealant Backer Rod (S-BR): Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended by sealant manufacturer for back-up of and compatibility with sealant. Where used with hot-applied sealant, provide heat-resistant type that will not be deteriorated by sealant application temperature as indicated.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Installer must examine substrates, (joint surfaces) and conditions under which joint sealer work is to be performed, and must notify Contractor in writing of unsatisfactory conditions. Do not proceed with joint sealer work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 JOINT PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements.
 1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellants; water; surface dirt and frost.
 2. Clean concrete, masonry, unglazed surface of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form release agents from concrete.
 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile and other non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
- B. Joint Priming:
 1. Prime joint substrates where indicated, or where recommended by sealant manufacturer based on pre-construction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape:
 - 1. Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION

- A. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.
- B. Set joint filler units at depth or position in joint as indicated to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.
- C. Install sealant backer rod for liquid-applied sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.
- D. Install bond breaker tape where indicated and where required by manufacturer's recommendations to ensure that liquid-applied sealants will perform as intended.
- E. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- F. Install liquid-applied sealants to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of beads; (not applicable to sealants in lapped joints).
- G. For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 5/8" deep nor less than 3/8" deep.
- H. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.
- I. Spillage:
 - 1. Do not allow sealants or compounds to overflow from confines of joints, or to spill onto adjoining work, or to migrate into voids of exposed finishes. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.
- J. Do not overheat or reheat hot-applied sealants; discard (do not use).
- K. Recess exposed edges of gaskets and exposed joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.
- L. Bond ends of gaskets together with adhesive or "weld" by other means as recommended by manufacturer to ensure continuous watertight and airtight performance. Miter-cut and bond ends at corners unless molded corner units are provided.

3.04 CURE AND PROTECTION

- A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.
- B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.
- C. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealers during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of substantial completion. Cure and protect sealants in a manner that will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants that are damaged or deteriorated during construction period.

END OF SECTION

SECTION 11300 – SEWAGE PUMPING STATIONS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the furnishing of sewage pumping stations, or lift stations, as indicated and specified. Only submersible pump lift stations will be allowed, with a minimum of two pumping units, unless otherwise indicated.
- B. Pump station identification:
 - 1. Pump stations shall be identified by a logical abbreviation of the collection system name followed by the number of the pump station.
 - 2. Pump stations that are constructed as additions to an existing collection system may use the abbreviation of the existing system. Existing abbreviations are as follows:
 - a. BB: Big Bear
 - b. BC: Big Cedar
 - c. CC: Coon Creek
 - d. EC: Emory Creek
 - e. KK: Kamp Kauai
 - f. KV: Kirbyville
 - g. MLD: Mildred
 - h. MV: Madison Valley
 - i. OB: Ozark Beach
 - j. PN: Powersite North
 - k. PP: Poverty Point
 - l. SC: Short Creek
 - m. SM: Spring Meadows
 - n. TC: Turkey Creek
 - o. TR: Trophy Run
 - p. TV: Taneyville
 - q. VOL: Venice on the Lake
 - 3. Pump stations shall be numbered sequentially from the beginning point of flow downstream through the collection system.
- C. All new pump stations are to include an oil-filled pressure gauge located on the force main in the valve vault.
- D. Related work specified elsewhere:
 - 1. Site Clearing: Section 02230.
 - 2. Earthwork: Section 02300.
 - 3. Granular Paving: Section 02505.
 - 4. Sanitary Sewerage: Section 02530.
 - 5. Chain Link Fence: Section 02820.
 - 6. Cast-In-Place Concrete: Section 03300.
 - 7. Protective Coating for New Concrete Sanitary Sewer Structures: Section 07200.
 - 8. Joint Sealers: Section 07900.
 - 9. Submersible Pumps: Section 11301.
 - 10. Electromagnetic Flow Meter: Section 13350.
 - 11. Wires and Cables: Section 16120.
 - 12. Electrical Boxes and Fittings: Section 16135.
 - 13. Electrical Connections for Equipment: Section 16142.
 - 14. Wiring Devices: Section 16143.

15. Motors and Accessories: Section 16150.
16. Standby Diesel Generator: Section 16264.
17. Automatic Transfer Switch: Section 16414.
18. Grounding: Section 16450.
19. Panelboards: Section 16470.
20. Motor Starters and Related Accessories: Section 16482.
21. Electric Power System: Section 16500.
22. Instrumentation System Coordination: Section 17010.
23. Control Panels: Section 17200.
24. Instrument Requirements: Section 17300.
25. Electrical Field Testing: Section 17600.

1.02 SUBMITTALS

- A. Shop drawings:
 1. Within 30 days after award of contract, and before any of the materials of this section are delivered to the job site, submit complete shop drawings and catalog cuts to the Engineer in accordance with the provisions of these Specifications, showing details of all equipment of this Section.
- B. Project Record Documents:
 1. Accurately record actual sewer inlet invert elevations at the wet well; wet well bottom elevation; pump on/off level switch elevations; and high level alarm elevation.
 2. Identify and describe all approved modifications. Unexpected modifications resulting from field variations shall be made only with the approval of the Engineer.

1.03 QUALITY ASSURANCE

- A. Applicable Standards:

1. HIS	Hydraulic Institute Standards
2. AFBMA Std. 11-78	Load and Fatigue Life for Roller Bearings
3. ASTM A36-84a	Structural Steel
4. ASTM A48-83	Gray Iron Castings
5. ASTM A176-83	Stainless and Heat-Resisting Steel Bars and Shapes
6. ASTM A322-82	Steel Bars, Alloy, Standard Grades
7. ASTM A351	Ferritic and Austenitic Steel Castings for High Temperature Service
8. ASTM A536	Ductile Iron Castings
9. ASTM A744	Castings-from-Chromium-Nickel, Corrosion Resistant for Severe Service
10. NFPA	National Fire Protection Association National Electrical Code
11. AGMA	American Gear Manufacturer's Association
12. ANSI	American National Standards Institute
13. NEMA	National Electrical Manufacturer's Association
14. IEEE	Institute of Electrical and Electronics Engineers

1.04 STARTUP

- A. All pump station site work, components, and appurtenances shall be completed, tested, and operational prior to startup, including the pump station force main, such that startup will be conducted under normal operating conditions.
- B. Site electrical work, including installation and testing of control panels, PLCs, and SCADA system shall be completed prior to the installation, seating, and startup and testing of the pumps.
- C. Contractor shall be responsible to maintain an updated project schedule and coordinate with subcontractors to ensure that all pump station site work, components, electrical work, and force main

installation is completed prior to startup. The Contractor shall notify the Owner and Engineer of any changes to the planned startup date, and such notification shall be provided to the Owner and Engineer in writing no less than 24 hours prior to the planned startup date.

PART 2 – PRODUCTS

2.01 GENERAL

- A. The arrangement shown on the drawings is based on the best information available to the Engineer at the time of design and is not intended to show exact dimensions particular to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the layout, electrical power supply, appurtenances, structural supports, foundations, connected piping, and valves indicated on the drawings or as specified in these specifications, in part or whole, may have to be changed in order to accommodate the pumping equipment furnished. Any modifications required for installation and operation of the equipment shall be made at the expense of the Contractor. All necessary calculations and drawings for any related redesign shall be submitted to the Engineer for approval prior to beginning the work.

2.02 ACCESS HATCHES

- A. Contractor shall provide access hatches as manufactured by Halliday Products or approved equal in accordance with the size of the pumps. An access hatch with safety grating shall be provided for the wet well and valve vault to combine covering of the opening and fall through protection. Hatches and safety grates shall have open and close assist.
- B. Door leaf shall be 1/4" thick aluminum diamond plate reinforced to a 300 psf live load. The frame shall be extruded aluminum with an integral anchor flange and door seat on all four (4) sides. The floor access door shall be equipped with a flush aluminum drop handle that does not protrude above the cover, and a stainless steel automatic hold open arm with a red vinyl grip to lock the cover in the open position. The door shall have stainless steel hinges with stainless steel tamper proof bolts and nuts. A staple for a padlock shall be supplied for security. All parts of the frame and cover shall be aluminum or stainless steel. Installation shall be in accordance with the manufacturer's attached instructions. Manufacturer shall guarantee against defects in materials and workmanship for a period of ten (10) years. Provide anti-slam lock, open and close assist, and nutrail.
- C. Grate shall open in the same direction as the door leaf and not cause restricted access to wet well or valve vault.
- D. The safety grate shall be made of 6061-T6 aluminum and designed per the "Specifications for Aluminum Structures", by the Aluminum Association, Inc., 5th Edition, Dec. 1986 for "Bridge Type Structures". This specification requires the manufacturer to use 38,000 psi as the ultimate strength of grade 6061-T6 aluminum and then a safety factor of 2.2 be applied, leaving a 17,300 psi design stress.
- E. The grating shall be designed to withstand a minimum live load of 300 pounds per square foot using 17,300 psi as the design stress for the aluminum. Deflection shall not exceed 1/150th of the span.
- F. Grate openings shall be 5" x 5", which will allow for visual inspection, limited maintenance and float adjustments while the safety grate fall through protection is left in place.
- G. Design must assure that the fall through protection is in place before the doors can be closed, thereby protecting the next operator. Each grate shall be provided with a permanent hinging system, which will lock the grate in the 90° position once opened.

- H. Each grate shall have an opening arm, which will allow opening of the grate, while providing the grate as a barrier between the operator and the pit. The opening arm shall also be equipped with a controlled confined space entry lock (lock provided by others). This locking device will prevent unauthorized entry to the confined space. The grating system will allow anyone to make visual inspection and float adjustments without entering the confined space.
- I. Each aluminum safety grate shall be coated with an OSHA type safety orange color, promoting visual awareness of the hazard, by a powder coat system, applied by the electrostatic spray process. The coating is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils and shall be baked at 350-375°F until cured.
- J. Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum.

2.03 PIPES, VALVES, AND FITTINGS

- A. All pipes, valves, and fittings shall be as specified in Section 02530 – Sanitary Sewerage.
- B. All pump discharge piping within the wet well and valve vault shall be flanged ductile iron pipe. All bolts shall be stainless steel.
- C. All pipe fittings shall be installed with stainless steel bolts.
- D. “Megalug” fittings shall be installed on each force main between the wet well and valve vault.
- E. PVC back flow preventors shall be installed on all floor drains in lift station vaults such that flow from leakages can drain into wet well while no wastewater collected in the wet well can flow into the downstream vaults.
- F. Valmatic Surgebuster check valves and Valmatic plug valves, and no others, shall be installed on each force main in the valve vault. All valves shall be equipped with open and closed indicators and backflow actuators on all check valves.
- G. Dismantling joints with tie rods shall be installed on each discharge line in the valve vault downstream of the plug valve and before the common header exiting the vault. Dismantling joint fittings shall be Ford FDJ, Romac DJ400, or approved equal.

2.04 WET WELLS

- A. Cast-in-place concrete structures shall be constructed as specified in Section 03300 – Cast-In-Place Concrete.
- B. For precast concrete structures, the precast manufacturer is to submit shop drawings on all precast structures. Precast manufacturers are to meet the following requirements:
 - 1. Precast manufacturer shall provide calculations documenting that the precast wet well structure will not float, should it become completely submerged, with a safety factor of 1.5, signed and sealed by a professional engineer licensed in the State of Missouri.
 - 2. Precast manufacturer shall provide calculations documenting that the structural integrity of the integral expanded base/flange will resist bending moments imparted during flotation, signed and sealed by a professional engineer licensed in the State of Missouri.
 - 3. Precast manufacturer to provide calculations that ensure selected wall thickness for the wet well provides adequate resistance from soil lateral loading to the depths shown on the plans, signed and sealed by a professional engineer licensed in the State of Missouri. Reference the project geotechnical engineering report for loading criteria.
 - 4. All circular precast concrete structures shall comply with ASTM C-478, with 4,000 psi concrete.

- 5. ACI 318 building code required for reinforced concrete.
- C. The bottom of the basin shall have a smooth troweled surface for mounting support casting.
- D. Wet well shall be ventilated through a 4" diameter PVC floor drain with stainless steel grate epoxied in a cored hole through the lid. Floor drain shall be Oatey, or approved equal.
- E. Backfill wet well in 8" lifts compacted to 95% Standard Proctor.
- F. No rock larger than 4" maximum dimension shall be placed within one foot of the exterior surface of the wet well.
- G. All exterior surfaces of the wet well shall be coated with two coats of bituminous material, or approved equal.
- H. All power cords and control cable handles and strain relief grips shall be stainless steel.
- I. Steel reinforced plastic manhole steps shall be mounted three feet from the wet well floor and at least every six feet above that. Steps shall serve as a stilling well for the containment of float switches and level transducer within the wet well. Steps shall be cast into structure by precaster or drilled and epoxied on site. No steps shall be mounted within the top 30 inches of the wet well to discourage use of the steps for entry. Stilling well shall be accessible from access hatch.
- J. Wet well shall include a pressure transducer, mounted as close to floor as possible.
- K. Pumping equipment shall be mounted to wet well base per manufacturer's spacing requirements.

2.05 VALVE VAULTS

- A. Cast-in-place concrete structures shall be constructed as specified in Section 03300 – Cast-In-Place Concrete.
- B. For precast concrete structures, the precast manufacturer is to submit shop drawings on all precast structures. Precast manufacturers are to meet the following requirements:
 - 1. Precast manufacturer shall provide calculations documenting that the precast valve vault structure will not float, should it become completely submerged, with a safety factor of 1.5, signed and sealed by a professional engineer licensed in the State of Missouri.
 - 2. Precast manufacturer shall provide calculations documenting that the structural integrity of the integral expanded base/flange will resist bending moments imparted during flotation, signed and sealed by a professional engineer licensed in the State of Missouri.
 - 3. Precast manufacturer to provide calculations that ensure selected wall thickness for the valve vault provides adequate resistance from soil lateral loading to the depths shown on the plans, signed and sealed by a professional engineer licensed in the State of Missouri. Reference the project geotechnical engineering report for loading criteria.
 - 4. All circular precast concrete structures shall comply with ASTM C-478, with 4,000 psi concrete.
 - 5. ACI 318 building code required for reinforced concrete.
- C. Valve vault shall be ventilated through a 4" diameter PVC floor drain with stainless steel grate epoxied in a cored hole through the lid. Floor drain shall be Oatey, or approved equal.
- D. Backfill valve vault in 8" lifts compacted to 95% Standard Proctor.
- E. No rock larger than 4" maximum dimension shall be placed within one foot of the exterior surface of the valve vault.

- F. All exterior surfaces of the valve vault shall be coated with two coats of bituminous material, or approved equal.
- G. Valve vaults shall include a GFI receptacle.
- H. Minimum clearance between wall of valve vault and outside of check valve shall be 24".

2.06 LEVEL CONTROLS

- A. Refer to Section 11301 – Submersible Pumps.

2.07 ELECTRICAL CONTROL PANELS

- A. The manufacturer of all panels shall be a UL listed shop for industrial control systems and shall provide evidence of such by serializing each unit per the requirements OF UL 508.
- B. The District will provide electrical control panels. Contractor shall coordinate programming and startup with the Engineer and District. See Section 17200 for additional specifications and details for control panel.

2.08 GENERATOR

- A. Contractor to provide a diesel-powered generator with automatic transfer switch as specified on the drawings. Generator and transfer switch will provide input to the PLC indicating current state of operation of generator and position of the transfer switch. Contractor is responsible for coordinating between pump supplier and generator supplier to endure compatibility. Reference Section 16264 for additional generator information. Contractor to provide full tank of fuel at substantial completion.

2.09 INSTRUCTIONS AND LABELS

- A. All panel boxes shall include a schematic wiring diagram displayed in cover of box. All terminals shall be clearly labeled with proper designation. Overload heater chart shall be displayed in box cover or heaters shall be listed on the drawing.

2.10 POWER

- A. The Contractor shall install a meter pedestal as shown on the Construction Plans. The Contractor shall be responsible for appropriate power supply extended to the lift station meter. The Contractor shall make arrangements with the local electrical power company to coordinate all electrical items of work. The Contractor will be responsible for all electrical works. The cost for the appropriate power supply shall be considered subsidiary to other pay items of work, unless otherwise indicated.

2.11 FINISHES

- A. All surfaces, unless otherwise indicated, shall be factory painted as specified in Section 05500 – Metal Fabrications.
- B. Coatings other than those listed in Section 05500 – Metal Fabrications may be submitted, but must receive the approval of the Engineer.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install and align pump and motor in conformance with manufacturer's recommendations and Hydraulic Institute Standards.
- B. Do not place grout for base plate until unit is in complete alignment.
- C. Make all electrical and control connections.
- D. Provide all necessary lubrication for initial start-up, testing and as required for final acceptance.
- E. Provide a complete unit with all materials, components and adjustments as required for successful operation.
- F. Have the manufacturer's service representative perform the items described above prior to start-up.

3.02 FIELD QUALITY CONTROL

- A. All tests shall be witnessed by the Engineer.
- B. All operational testing shall include the District, who will be responsible for verifying the PLC program logic.
- C. Make all necessary equipment adjustments and corrective work indicated by tests.
- D. Submit two (2) copies of a written test report to Engineer showing operations performed and results obtained for each unit.
- E. Equipment Tests:
 - 1. Check performance of all components as a functioning unit.
 - 2. Check vibration and alignment on each unit and make necessary adjustments such that equipment vibration velocity is less than the maximum value set by Hydraulic Institute Standards.
- F. Operation 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 observing performance.
- G. Inspection:
 - 1. Inspection shall be performed on each pumping unit by a qualified service engineer from the manufacturer of the pumps.
 - 2. Inspection shall be performed within 60 days prior to date of warranty expiration.
 - 3. Inspection shall ascertain or appraise the following:
 - a. Status of compliance with new equipment and controls performance specifications after normal usage.
 - b. Adherence to manufacturer's recommended maintenance and operation of equipment.
 - 4. Adjustments shall be made as necessary to restore equipment within original tolerances and performance specifications.
 - 5. Redowelling shall be performed if alignment adjustments are made.

6. Two (2) copies of a written report shall be submitted to Engineer covering all inspection items, corrective work performed and recommendations, when applicable.

END OF SECTION

SECTION 11301 – SUBMERSIBLE PUMPS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the furnishing of submersible pumps, and their accessories as indicated and specified. The District shall be responsible for providing the pump station control panels and generators to ensure proper sizing and coordination between all equipment.
- B. Submersible pumps shall be furnished complete with pump casings, shafts, bearings, seals, lubrication, piping assemblies, guide rails, anchor bolts, motors, power cable, and all other parts and accessories indicated to make a complete working system. All pumps supplied, including motors, shall be by one manufacturer.
- C. Equipment specified under this section to be furnished by the pump manufacturer, who shall be responsible for the adequacy and compatibility of all pumping unit components. Any component of each complete pumping unit not provided by the pump manufacturer shall be designed, fabricated, tested, and installed by factory-authorized representatives experienced in the design and manufacture of said equipment.
- D. Related work specified elsewhere:
 - 1. Sewage Pumping Stations: Section 11300.
 - 2. Wires and Cables: Section 16120.
 - 3. Electrical Boxes and Fittings: Section 16135.
 - 4. Electrical Connections for Equipment: Section 16142.
 - 5. Wiring Devices: Section 16143.
 - 6. Motors and Accessories: Section 16150.
 - 7. Standby Diesel Generator: Section 16264.
 - 8. Automatic Transfer Switch: Section 16414.
 - 9. Grounding: Section 16450.
 - 10. Panelboards: Section 16470.
 - 11. Motor Starters and Related Accessories: Section 16482.
 - 12. Electric Power System: Section 16500.
 - 13. Instrumentation System Coordination: Section 17010.
 - 14. Control Panels: Section 17200.
 - 15. Instrument Requirements: Section 17300.
 - 16. Electrical Field Testing: Section 17600.

1.02 SYSTEM DESCRIPTION

- A. Design for the Following Conditions: (Engineer to complete table)

Lift Station Name		
GPM		
TDH, Static Head (ft)		
HP		
VAC, Phase		
Solids Dia.		

Discharge Size		
Explosion Proof		
RPM		
Qty Pumps		
VFD		
Soft Starts		

- B. Pumps shall be capable of operating continuously.
- C. Characteristics of the liquid to be pumped are as follows:
 - 1. Domestic wastewater
 - 2. Temperature 50°F to 80°F

1.03 SUBMITTALS

- A. Shop drawings:
 - 1. Within 30 days after award of contract, and before any of the materials of this section are delivered to the job site, submit complete shop drawings and catalog cuts to the Engineer in accordance with the provisions of these Specifications, showing details of all equipment of this Section.
- B. Project Record Documents:
 - 1. Identify and describe all approved modifications. Unexpected modifications resulting from field variations shall be made only with the approval of the Engineer.
- C. Operation and Maintenance Manuals
 - 1. General:
 - a. For each type of equipment indicated in the equipment schedule, the equipment supplier shall prepare an operation and maintenance manual covering:
 - i. Equipment function, normal operating characteristics and limiting conditions.
 - ii. Assembly installation, alignment, adjustment and checking instructions.
 - iii. Operating instructions for start-up, routine and normal operation, regulation and control, shutdown and emergency conditions.
 - iv. Lubrication and maintenance instructions.
 - v. Guide to "troubleshooting".
 - vi. Parts lists and predicted life of parts subject to wear.
 - vii. Outline, cross section and assembly drawings; engineering data; and wiring diagrams.
 - viii. Test data and performance curves, where applicable.
 - ix. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
 - 2. Format:
 - a. Manuals shall be printed on heavy, first quality paper, 8 1/2 by 11 inch size with standard 3-hole punching. Drawings and diagrams shall be reduced to 8 1/2 by 11 inches or 11 by 17 inches. Where reduction is not practicable, larger drawings shall be folded separately and placed in envelopes which are bound into the manuals. Each envelope shall bear suitable identification on the outside.
 - 3. Number of copies:
 - a. Three copies of each manual, bound in heavy paper covers bearing suitable identification, shall be submitted to the Engineer prior to the date of shipment of the equipment.

1.04 QUALITY ASSURANCE

- A. General:

1. The pump(s) shall be heavy duty, electric submersible, centrifugal non-clog units designed for handling unscreened wastewater and shall be fully guaranteed for this use. The pumps provided shall be capable of operating in a liquid temperature up to 104°F as specified by the National Electrical Manufacturers Association (NEMA) and Factory Mutual (FM), motors operating below 104°F shall not be accepted.
2. The pump and motor units shall be suitable for continuous operation at full nameplate load while the motor is completely submerged.
3. The pump and motor units provided under this specification shall be assembled by the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty. Pump Supplier shall supply mechanical seals per specifications.

B. Applicable Standards:

- | | |
|---------------------|---|
| 1. HIS | Hydraulic Institute Standards |
| 2. AFBMA Std. 11-78 | Load and Fatigue Life for Roller Bearings |
| 3. ASTM A36-84a | Structural Steel |
| 4. ASTM A48-83 | Gray Iron Castings |
| 5. ASTM A176-83 | Stainless and Heat-Resisting Steel Bars and Shapes |
| 6. ASTM A322-82 | Steel Bars, Alloy, Standard Grades |
| 7. ASTM A351 | Ferritic and Austenitic Steel Castings for High Temperature Service |
| 8. ASTM A536 | Ductile Iron Castings |
| 9. ASTM A744 | Castings-from-Chromium-Nickel, Corrosion Resistant for Severe Service |
| 10. NEPA | National Fire Protection Association National Electrical Code |
| 11. AGMA | American Gear Manufacturer's Association |
| 12. ANSI | American National Standards Institute |
| 13. NEMA | National Electrical Manufacturer's Association |
| 14. IEEE | Institute of Electrical and Electronics Engineers |

1.05 WARRANTY

- A. The pumps and motors shall be provided with 60 months (5 years) warranty against defects in materials and or workmanship. The warranty shall cover the entire pump and motor, not individual components. Upon warranty occurrence, the manufacturer's authorized service center shall remove the pump, repair, reinstall and provide start up on the repaired pump. A detailed failure analysis shall be submitted to the Owner for their records summarizing corrective action taken.
- B. The pump manufacturer supplier shall have a factory authorized repair facility capable of repairing equipment that is labeled UL Listed or FM Approved for pump and motor repair and direct factory service center capable of completely servicing and stocking identical drive units and spare parts for the proposed pumps. The pump supplier shall provide an emergency field service center with authorized factory pump and motor technicians available 365 days per year, 24 hours per day.
- C. Each pumping unit shall be designed so that reverse rotation at rated head will not cause damage to any component.
- D. Pump manufacturer shall ensure spare parts availability for 15 years.

1.06 SYSTEM START-UP

- A. The equipment manufacturer shall furnish the services of a qualified factory-trained field service Engineer for one trip of at least two 8-hour days at the site to inspect the installation and instruct the Owner's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the Contractor shall have the manufacturer perform the following:

1. Megger stator and power cables.
 2. Check seal lubrication.
 3. Check for proper rotation.
 4. Check power supply voltage.
 5. Measure motor operating load and no load current.
 6. Check pumping rate for conformance with design duty points.
- B. During these trips, the manufacturer's service representative shall review recommended operation and maintenance procedures with the Owner's operators.
- C. It is the responsibility of the Contractor to have all pump station site work, components, appurtenances, electrical work, and force main completed and tested prior to the scheduled time allocated for the equipment manufacturer's qualified factory-trained field service Engineer to arrive on site for system startup.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Per Missouri Code of State Regulations (CSR) 10-CSR 20-4.040 the pump equipment is base-bid for interchangeability of parts and equipment with other pumping equipment for the District.
- B. The manufacturer shall be experienced in design and manufacture of submersible pump and submersible motor equipment and accessories including submersible installations for a minimum of 10 years and 100,000 installed pumps in the United States. Submersible pumping equipment shall be one of the following:
1. Flygt (basis of design)
- C. A manufacturer being named in this specification notwithstanding, all equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this specification. Conditional approval by the Engineer under this section is based on a general review only and in no way constitutes final approval of equipment, nor waives any requirement of these specifications, nor relieves the Contractor or Manufacturer of any degree of responsibility for compliance with specific requirements of other portions of these specifications.
1. The proposal shall include drawings, specifications, product literature, certified shaft deflection calculation of less than 0.2 mils measured at the lower mechanical seal taking into account hydraulic and electro-magnetic forces, and certified bearing calculations to meet specifications.
 2. Provide a list of 10 installations of same pump size and horsepower within 100 miles radius of project site with contacts and phone numbers having at least five years of operation.
 3. Provide evidence of manufacturing capability including a list of professional qualifications of personnel and quality control practices.
 4. Certify complete compliance without modification of structures, foundations or electrical equipment.
 5. The pump manufacturer supplier shall certify they have a factory authorized repair facility capable of repairing equipment that is labeled UL Listed or FM Approved for pump and motor repair and direct factory service center capable of completely servicing and stocking identical drive units and spare parts for the proposed pumps within 150 miles of the project location.
 6. The pumps and motors shall be provided with 60 months (5 years) warranty against defects in materials and or workmanship.

2.02 GENERAL

- A. The Contractor will furnish and install non-clog submersible pumps with guide rails, suitable for wet well installation. Each pump shall be supplied with motor, close coupled volute, cast iron discharge elbow, guide bar brackets, power cable, and accessories as specified.
- B. Each pump, motor and power cable shall be approved for submersible use as determined and approved by UL or FM. The motor shall be capable of operating in pumped media up to 104°F. The motor thermal switch shall be safely operated up to 260°F. The pump motor shall also be protected by a water penetration detector.
- C. Each complete system, including pump, motor, and all appurtenances, shall have no dangerous critical or resonance frequencies or multiples of resonance frequencies within 20 percent above and 35 percent below the speed range required by the pump to meet the specified operating conditions.
 - 1. For the purposes of design, a dangerous vibratory critical speed shall be defined as one which produces a torsional stress exceeding 3,500 psi. The Contractor shall be responsible for the analysis of critical speeds and the complete mass elastic system.
 - 2. All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure. The Contractor shall be responsible for this coordination and shall ensure that the component parts do not interact with each other to produce unacceptable vibrations, stresses, or undesirable conditions.
 - 3. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire full-speed operating curve.
- D. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the control cabinet without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. Stainless steel Kellum grips shall be provided with the cable. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet. Stainless steel J hooks shall be provided as shown in plans for support of power cable in wet well.
- E. Pumps shall have factory installed lifting bales for use with the District's equipment. Lifting bale shall be a minimum of six inch diameter. No chain lifting system required.
- F. Pump head capacity curve shall be continually falling from shut-off.
- G. Furnish stainless steel upper guide rail bracket and electrical cable lifting chain holder suitable for mounting on a structure wall.

2.03 PUMP DESIGN

- A. Each pump shall be automatically and firmly connected to the discharge connection, guided by no less than two stainless steel guide bars extending from the top of the station to the discharge connection. The construction shall be such that the pump(s) will be automatically connected to the discharge piping when lowered into place on the discharge connection. The pump(s) shall be easily removable for inspection for service. There shall be no need for personnel to enter the pump pit for any purpose.
- B. A sliding guide bracket shall be an integral part of the pumping unit and the pump casing shall have a machined connection with a bracket to connect with the cast iron discharge connection, which shall be bolted to the floor of the wet well and so designed as to receive the pump connection without the need of any bolts, nuts or gaskets. Sealing of the discharge interface with a diaphragm O-ring or profile gasket will not be acceptable.

- C. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact. No portion of the pump shall bear directly on the floor of the wet well.
- D. Two guide pipes shall be furnished and installed for each pump to permit raising and lowering the pump. Single pipe and cable systems are not acceptable. Guide pipes shall be of stainless steel pipe of adequate length that extend from the lower guide holder on the pump discharge connection to the upper brackets mounted on the access frame.

2.04 PUMP CONSTRUCTION

- A. Major pump components including volute, impeller and motor casing shall be of grey cast iron, ASTM A-48, Class 35b, with smooth surfaces devoid of blowholes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel or brass construction. All metal surfaces coming into contact with the pumpage, other than stainless steel, shall be protected by factory applied spray high solids epoxy coating system on the exterior of the pump with minimum 10 mils. Class 30 or Class 40 cast iron are unacceptable due to lower corrosion resistance and less vibration dampening characteristics.
- B. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
- C. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

2.05 CABLE ENTRY

- A. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of the sealing cable. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary systems shall not be acceptable. The assembly shall provide ease of changing the cable when necessary using the same entry seal.

2.06 MOTOR

- A. Each pump shall be equipped with a submersible electric motor with horsepower rating that is non-overloading throughout the entire pump performance curve.
- B. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The motor shall be inverter duty/VFD rated in accordance with NEMA MG1 standards. The stator windings and stator leads shall be insulated with moisture resistant Class H insulation rated for 180°C. The use of double or triple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer O-ring seal. Connection between

the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be assembled by the same manufacturer and provide a written guaranty for parts replacement and availability for 15 years.

- C. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting current and torque.
- D. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the control cabinet without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
- E. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through operating flows and head ranges shown for each station.

2.07 BEARINGS

- A. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. Oil lubricated bearings are not acceptable. The upper motor bearing shall be a two row angular contact ball bearing. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. Excessive shaft overhang and single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 at any point along the published pump curve at maximum product speed.

2.08 COOLING SYSTEM

- A. General - Each unit shall be provided with an adequately designed integral cooling system that allows up to 20 motor starts per hour with a non submerged motor on a continuous basis in an ambient 104°F environment, and in a standard available version, with no damage to motor windings, bearings, or drive shaft seals. The pump supplied under this specification shall be suitable for continuous operation; under submerged, partially submerged or dry conditions. Without de-rating the motor, the pump shall be able to pump continuously with the motor exposed (the water level at the top of the volute) and under full load, without the need of spray systems or air moving equipment with an ambient temperature of 104°F (40°C). The motor shall not be rated at 30°C. Coolant systems using fans, blowers, or auxiliary external cooling systems are not acceptable. A motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat, regardless of the type of pump installation. An impeller, integral to the closed-loop cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The coolant circulation passages should be sized to provide enhanced heat transfer from stator housing to coolant through insured turbulent flow of coolant as it passes the stator housing. The cooling system shall incorporate one fill port and one drain port in the cooling jacket. Water Jacket System (using a water jacket, which circulates externally supplied cooling water or a micro-filtered portion of the pumped liquid for heat dissipation is not acceptable).

2.09 MECHANICAL SEAL

- A. Each pump shall be provided with a positively driven dual, cartridge, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating

corrosion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance. Seals that utilize an O-ring or rubber bellows elastomer as the seal drive mechanism will not be acceptable. The seal shall be a cartridge seal and individual seals shall not be acceptable.

- B. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.
- C. The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action. This spiral track or "spin-out" creates a "flushing" action, forcing abrasive particles away, to reduce wear and extend seal, shaft and impeller life. In lieu of "spin-out", two complete sets of spare mechanical seals (tungsten carbide vs tungsten carbide), shaft shall be provided for each pump.

2.10 PUMP SHAFT

- A. The pump shaft shall be an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be minimum 420 stainless steel. Shaft sleeves will not be accepted since they only protect the shaft around the lower mechanical seal.

2.11 IMPELLER

- A. The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge, and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt, and shall be coated with alkyd resin primer.

2.12 VOLUTE

- A. The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and volute housing.

2.13 PROTECTION

- A. A leakage sensor shall be available to detect water and oil in the stator chamber. When activated, the sensor will send an alarm to the control panel in both local and remote modes. Use of voltage sensitive solid state sensors and trip temperature above 125°C (260°F) shall not be allowed.
- B. The motor stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125°C (260°F) the thermal switches shall open, stop the motor and activate an alarm. Motors that open above 125°C (260°F) are not acceptable.

2.14 ACCESSORIES

- A. Pump Discharge Connection:
 - 1. Connected to discharge piping and anchored to sump floor with 304 stainless-steel anchor bolts.
 - 2. Designed to receive pump discharge connection without bolts.
 - 3. Integral with guide rail.
 - 4. Cast or ductile iron.
 - 5. Flanges shall conform to ANSI B16.1.
 - 6. Discharge connection shall be capable of handling the full weight of the pump. No legs will be permitted on the pumps to support the weight.
- B. Lifting Eye:
 - 1. Provide factory installed lifting bale, minimum of 6" diameter.
- C. Guide Rails:
 - 1. 304 stainless steel pipe, Schedule 40.
 - 2. Size as recommended by pump manufacturer.
 - 3. Shall not support any portion of the pump weight.
 - 4. All hardware shall be 304 stainless steel.

2.15 LEVEL CONTROLS

- A. Stations shall use submersible level transducers and float switches for wet well level control. Contractor must provide all equipment and material as specified herein.
- B. Submersible level transducers shall generate a 4-20mA signal and be connected to the PLC via a 4-20mA surge protector. The surge protector must be sized for a 24 VDC circuit and shall be a Leviton 3420-35 or approved equal.
- C. Submersible Level transducer must be sized to accurately monitor the entire depth of the wet well.
- D. Submersible level transducer shall be Tek-Trol Tek-Sub 4800D, with stainless steel housing and protective cage, equipped with a vent filter or aneroid bellows, or approved equal.
- E. Submersible level transducers must be installed in wet well per Section 11300 – Sewage Pumping Stations, running the full depth of the wet well. Pressure transducer shall be mounted as close to floor as possible. Access to the transducer must be from the top of the wet well via hatch.
- F. Float cord connection controls shall be STO flexible cord. An alarm light will stay illuminated until manually reset if the low level float or high level float become activated.
- G. Floats shall be supported with a factory supplied stainless steel bracket. Floats shall be ROTO-FLOAT, Type S, Anchor Scientific Inc., with built in weight. All floats shall be protected by intrinsically safe relay (Diversified Electronics Model 150120AFA).

- H. Floats shall be attached to a minimum five position stainless steel float control level bracket that is anchored near the top of the wetwell allowing floats to be adjusted without entering the wetwell. Float wires shall be continuous to the control cabinet and have a length adequate to reach control cabinet without splices.
- I. Normal pump cycle operations will be controlled by the PLC via the transducer. Floats shall serve as a backup and operate independent of the PLC. The “lead” float being positioned ABOVE the high-water level of the transducer and the “all off” float being positioned BELOW the off level of the transducer.

2.16 ELECTRICAL CONTROL PANELS

- A. Refer to Section 11300 – Sewage Pumping Stations.

2.17 GENERATOR

- A. Refer to Section 11300 – Sewage Pumping Stations.

2.18 INSTRUCTIONS AND LABELS

- A. Refer to Section 11300 – Sewage Pumping Stations.

2.19 POWER

- A. Refer to Section 11300 – Sewage Pumping Stations.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install and align pump and motor in conformance with manufacturer's recommendations and Hydraulic Institute Standards.
- B. Do not place grout for base plate until unit is in complete alignment.
- C. Make all electrical and control connections.
- D. Provide all necessary lubrication for initial start-up, testing and as required for final acceptance.
- E. Provide a complete unit with all materials, components and adjustments as required for successful operation.
- F. Have the manufacturer's service representative perform the items described above prior to start-up.

3.02 FIELD QUALITY CONTROL

- A. All tests shall be witnessed by the Engineer.
- B. All operational testing shall include the District, who will be responsible for verifying the PLC program logic.
- C. Make all necessary equipment adjustments and corrective work indicated by tests.

- D. Submit two (2) copies of a written test report to Engineer showing operations performed and results obtained for each unit.
- E. Equipment Tests:
 - 1. Check performance of all components as a functioning unit.
 - 2. Check vibration and alignment on each unit and make necessary adjustments such that equipment vibration velocity is less than the maximum value set by Hydraulic Institute Standards.
- F. Operation 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 observing performance.
- G. Inspection:
 - 1. Inspection shall be performed on each pumping unit by a qualified service engineer from the manufacturer of the pumps.
 - 2. Inspection shall be performed within 60 days prior to date of warranty expiration.
 - 3. Inspection shall ascertain or appraise the following:
 - a. Status of compliance with new equipment and controls performance specifications after normal usage.
 - b. Adherence to manufacturer's recommended maintenance and operation of equipment.
 - 4. Adjustments shall be made as necessary to restore equipment within original tolerances and performance specifications.
 - 5. Redowelling shall be performed if alignment adjustments are made.
 - 6. Two (2) copies of a written report shall be submitted to Engineer covering all inspection items, corrective work performed and recommendations, when applicable.

END OF SECTION

SECTION 11305 – GRINDER PUMP STATIONS (SEMI-POSITIVE DISPLACEMENT TYPE PUMPS)

PART 1 – GENERAL

1.01 GENERAL DESCRIPTION

The MANUFACTURER shall furnish complete factory-built and tested Wetwell/Drywell Grinder Pump Station(s), each consisting of grinder pump(s) suitably mounted in a basin constructed of high density polyethylene (HDPE) for simplex stations and HDPE or Fiberglass Reinforced Polyester Resin for duplex stations with dimensions and capacities as show on the Contract Drawings, NEMA 6P electrical quick disconnect (EQD), pump removal system, stainless steel discharge assembly/shut-off valve, anti-siphon valve/check valve, each assembled in the basin, electrical alarm panel and all necessary internal wiring and controls. Component type grinder pump systems that require field assembly will not be acceptable due to the potential problems that can occur during field assembly. All components and materials shall be in accordance with section 2.0 of this Product Specification. For ease of serviceability, all pump, motor/grinder units shall be of like type and horsepower throughout the system.

1.02 SUBMITTALS

After receipt of notice to proceed, the Contractor shall furnish a minimum of four sets of shop drawings detailing the equipment to be furnished including dimensional data and materials of construction. The Engineer shall promptly review this data, and return two copies as accepted, or with requested modifications. Upon receipt of accepted shop drawings, the Manufacturer shall proceed immediately with fabrication of the equipment.

1.03 MANUFACTURER

- A. Grinder pump stations, complete with all appurtenances, form an integral system, and as such, shall be supplied by one grinder pump station Manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The Manufacturer shall provide, upon request, a reference and contact list from ten of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification.
- B. The Manufacturer shall be experienced in design and manufacture of grinder pump and grinder pump motor equipment and accessories including grinder pump installations for a minimum of 10 years and 100,000 installed pumps in the United States. Grinder pumping equipment shall be one of the following:
 - 1. E-One (basis of design), or
 - 2. Engineer Approved Equal
- C. A Manufacturer being named in this specification notwithstanding, all equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this specification. Pre-submittal: Equipment must be conditionally approved by the Engineer in writing at least ten (10) days prior to bid for all substitute Manufacturers in order to be offered for this project. The Engineer shall furnish in writing, via addendum, acceptance or rejection of substitution/alternate submittal. In no case shall equipment be accepted for this project if not approved by the Engineer in writing prior to bid. Conditional approval by the Engineer under this section is based on a general review only and in no way constitutes final approval of equipment, nor waives any requirement of these specifications,

nor relieves the Contractor or Manufacturer of any degree of responsibility for compliance with specific requirements of other portions of these specifications.

1. Provide a list of 10 installations of same pump size and horsepower within 100 miles radius of project side with contacts and phone numbers having at least five years of operation.
2. Provide evidence of manufacturing capability including a list of professional qualifications of personnel and quality control practices.
3. Certify complete compliance without modification of structures, foundations or electrical equipment.
4. The pump Manufacturer supplier shall certify they have a factory authorized repair facility capable of repairing equipment that is labeled UL Listed or FM Approved for pump and motor repair and direct factory service center capable of completely servicing and stocking identical drive units and spare parts for the proposed pumps within 50 miles of the project location.
5. Attention is directed to the fact that the drawings and overall system design are based on a particular piece of equipment from a particular Manufacturer. These specifications are intended to provide guidelines for standard equipment of a recognized Manufacturer who already meets all the requirements of this specification.

1.04 EXPERIENCE CLAUSE

- A. The equipment furnished hereunder shall be the product of a company experienced in the design and manufacture of grinder pumps specifically designed for use in low pressure systems. All Manufacturers proposing equipment for this project shall have at least 10 years of experience in the design and manufacture of units of identical size(s) and performance to the specified units. All Manufacturers proposing equipment for this project must also have not less than 500 successful installations of low pressure sewer systems utilizing grinder pumps of like type to the grinder pumps specified herein. An installation is defined as a minimum of 25 pumps discharging into a common force main which forms a low pressure sewer system. The Contractor proposing alternate equipment shall also submit, as part of the bid schedule, an installation list with contact person(s), phone number(s) and date(s) of at least 10 installations of the type of pump specified herein that have been in operation for at least 10 years.
 1. In lieu of this experience clause, the Contractor of alternate equipment will be required to submit a 5-year performance bond for 100 percent of the stipulated cost of the equipment as bid and as shown in the Bid Schedule. This performance bond will be used to guarantee the replacement of the equipment in the event that it fails within the bond period.

1.05 OPERATING CONDITIONS

The pumps shall be capable of delivering 15 GPM against a rated total dynamic head of 0 feet (0 PSIG), 11 GPM against a rated total dynamic head of 92 feet (40 PSIG), and 7.8 GPM against a rated total dynamic head of 185 feet (80 PSIG). The pump(s) must also be capable of operating at negative total dynamic head without overloading the motor(s). Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

1.06 WARRANTY

The grinder pump Manufacturer shall provide a part(s) and labor warranty on the complete station and accessories, including, but not limited to, the panel for a period of 24 months after notice of Owner's acceptance, but no greater than 27 months after receipt of shipment. Any manufacturing defects found during the warranty period will be reported to the Contractor or Manufacturer by the Owner and will be corrected by the Manufacturer at no cost to the Owner.

1.07 WARRANTY PERFORMANCE CERTIFICATION

Manufacturer shall provide with their submittal a Warranty Performance Certification statement executed by the most senior executive officer of the grinder pump Manufacturer, which certifies a minimum of a 24-

month warranty. They must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, including all associated labor and shipping fees, and certify that the Manufacturer will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventive maintenance type requirements shall be included in this form as exclusions. These requirements include, but are not limited to, unjamming of grinder mechanism, periodic motor maintenance, and periodic cleaning of liquid level controls. Should the Contractor elect to submit a performance bond in lieu of the experience clause outlined above, this Warranty Performance Certification shall also be used as a criterion to evaluate the Contractor's performance over the warranty period.

PART 2 – PRODUCTS

2.01 PUMP

The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. Double radial O-ring seals are required at all casting joints to minimize corrosion and create a protective barrier. All pump castings shall be cast iron, fully epoxy coated to 8-10 mil Nominal dry thickness, wet applied. The rotor shall be through-hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. This material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material because it does not exhibit the properties as outlined above and required for wastewater service.

2.02 GRINDER

The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller (cutter wheel) assembly shall be securely fastened to the pump motor shaft by means of a threaded connection attaching the grinder impeller to the motor shaft. Attachment by means of pins or keys will not be acceptable. The grinder impeller shall be a one-piece, 4140 cutter wheel of the rotating type with inductively hardened cutter teeth. The cutter teeth shall be inductively hardened to Rockwell 50 – 60c for abrasion resistance. The shredder ring shall be of the stationary type and the material shall be white cast iron. The teeth shall be ground into the material to achieve effective grinding. The shredder ring shall have a staggered tooth pattern with only one edge engaged at a time, maximizing the cutting torque. These materials have been chosen for their capacity to perform in the intended environment as they are materials with wear and corrosive resistant properties.

This assembly shall be dynamically balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures. The grinder shall be constructed so as to minimize clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:

- A. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
- B. The maximum flow rate through the cutting mechanism must not exceed 4 feet per second. This is a critical design element to minimize jamming and as such must be adhered to.
- C. The inlet shroud shall have a diameter of no less than 5 inches. Inlet shrouds that are less than 5 inches in diameter will not be accepted due to their inability to maintain the specified 4 feet per second maximum inlet velocity which by design prevents unnecessary jamming of the cutter mechanism and minimizes blinding of the pump by large objects that block the inlet shroud.

- D. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.

The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, wipes, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter stainless steel discharge piping.

2.03 ELECTRIC MOTOR

As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with Class F installation, low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. The start/run capacitor and potential relay shall be inside control cabinet. The motor shall be press-fit into the casting for better heat transfer and longer winding life. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted because of their reduced starting torque and consequent diminished grinding capability. The wet portion of the motor armature must be 300 Series stainless. To reduce the potential of environmental concerns, the expense of handling and disposing of oil, and the associated maintenance costs, oil-filled motors will not be accepted.

2.04 MECHANICAL SEAL

The pump/core shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

2.05 TANK AND INTEGRAL ACCESSWAY

The tank shall be a Wetwell/Drywell design made of high density polyethylene, with a grade selected to provide the necessary environmental stress cracking resistance. Corrugated sections are to be made of a double wall construction with the internal wall being generally smooth to promote scouring. The corrugations of the outside wall are to be a minimum amplitude of 1-1/2" to provide necessary transverse stiffness. Any incidental sections of a single wall construction are to be 0.250" thick (minimum). All seams created during tank construction are to be thermally welded and factory tested for leak tightness. The tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.

The tank shall be furnished with one EPDM grommet fitting to accept a 4.50" OD DWV or Schedule 40 pipe. The tank capacities shall be as shown on the contract drawings.

The Drywell accessway shall be an integral extension of the Wetwell assembly and shall include a lockable cover assembly providing low profile mounting and watertight capability. The accessway design and construction shall enable field adjustment of the station height in increments of 4" or less without the use of any adhesives or sealants requiring cure time before installation can be completed.

The station shall have all necessary penetrations molded in and factory sealed. To ensure a leak free installation no field penetrations will be acceptable.

All discharge piping shall be constructed of 304 stainless steel. The discharge shall terminate outside the accessway bulkhead with a stainless steel, 1-1/4" Female NPT fitting. The discharge piping shall include a

stainless steel ball valve rated for 235 psi WOG; PVC ball valves or brass ball/gate will not be accepted. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

The accessway shall include a single NEMA 6P Electrical Quick Disconnect (EQD) for all power and control functions, factory installed with accessway penetrations warranted by the manufacturer to be watertight. The EQD will be supplied with 32', 25' of useable Electrical Supply Cable (ESC) outside the station, to connect to the alarm panel. The ESC shall be installed in the basin by the manufacturer. Field assembly of the ESC into the basin is not acceptable because of potential workmanship issues. The EQD shall require no tools for connecting, seal against water before the electrical connection is made, and include radial seals to assure a watertight seal regardless of tightening torque. Plug-type connections of the power cable onto the pump housing will not be acceptable due to the potential for leaks and electrical shorts. A junction box shall not be permitted in the accessway due to the large number of potential leak points. The EQD shall be so designed to be conducive to field wiring as required. The accessway shall also include an integral 2-inch vent to prevent sewage gases from accumulating in the tank.

2.06 TANK & INTEGRAL ACCESSWAY

The tank shall be a Wetwell/Drywell design custom molded of fiberglass reinforced polyester resin with a high density polyethylene access way. Access way corrugated sections are to be made of a double wall construction with the internal wall being generally smooth to promote scouring. The corrugations of the outside wall are to be a minimum amplitude of 1-1/2" to provide necessary transverse stiffness. Any incidental sections of a single wall construction are to be 0.250" thick (minimum). All polyethylene seams created during tank construction are to be thermally welded and factory tested for leak tightness. The tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.

The tank shall be furnished with one EPDM grommet fitting to accept a 4.50" OD DWV or Schedule 40 pipe. The tank capacities shall be as shown on the contract drawings.

The Drywell accessway shall be an integral extension of the Wetwell assembly and shall include a lockable cover assembly providing low profile mounting and watertight capability. The cover shall be high density polyethylene, green in color, with a load rating of 150 lbs per square foot. The accessway design and construction shall enable field adjustment of the station height in increments of 3" or less without the use of any adhesives or sealants requiring cure time before installation can be completed.

The station shall have all necessary penetrations molded in and factory sealed. To ensure a leak free installation no field penetrations will be acceptable.

All discharge piping shall be constructed of 304 stainless steel. The discharge shall terminate outside the accessway bulkhead with a stainless steel, 1-1/4" Female NPT fitting. The discharge piping shall include a stainless steel ball valve rated for 235 psi WOG; PVC ball valves or brass ball/gate will not be accepted. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

The accessway shall include a single NEMA 6P Electrical Quick Disconnect (EQD) for all power and control functions, factory installed with accessway penetrations warranted by the manufacturer to be watertight. The EQD will be supplied with 32', 25' of useable Electrical Supply Cable (ESC) outside the station, to connect to the alarm panel. The ESC shall be installed in the basin by the manufacturer. Field assembly of the ESC into the basin is not acceptable because of potential workmanship issues. The EQD shall require no tools for connecting, seal against water before the electrical connection is made, and include radial seals to assure a watertight seal regardless of tightening torque. Plug-type connections of the power cable onto the pump housing will not be acceptable due to the potential for leaks and electrical shorts. A junction box shall not be permitted in the accessway due to the large number of potential leak points. The EQD shall be so

designed to be conducive to field wiring as required. The accessway shall also include an integral 2-inch vent to prevent sewage gases from accumulating in the tank.

2.07 CHECK VALVE

The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the stainless steel discharge piping. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 Series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure. The valve body shall be an injection molded part made of an engineered thermoplastic resin. The valve shall be rated for continuous operating pressure of 235 psi. Ball-type check valves are unacceptable due to their limited sealing capacity in slurry applications.

2.08 ANTI-SIPHON VALVE

The pump discharge shall be equipped with a factory-installed, gravity-operated, flapper-type integral anti-siphon valve built into the stainless steel discharge piping. Moving parts will be made of 300 Series stainless steel and fabric-reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A nonmetallic hinge shall be an integral part of the flapper assembly, providing a maximum degree of freedom to ensure proper operation even at a very low pressure. The valve body shall be injection-molded from an engineered thermoplastic resin. Holes or ports in the discharge piping are not acceptable anti-siphon devices due to their tendency to clog from the solids in the slurry being pumped. The anti-siphon port diameter shall be no less than 60% of the inside diameter of the pump discharge piping.

2.09 CORE UNIT

The grinder pump station shall have a cartridge type, easily removable core assembly consisting of pump, motor, grinder, all motor controls, check valve, anti-siphon valve, level controls, electrical quick disconnect and wiring. The core unit shall be installed in the basin by the manufacturer. Field assembly of the pump and controls into the basin is not acceptable because of potential workmanship issues and increased installation time. In some cases, stations taller than 96" may be shipped on their side without the cores assembled in the basin for freight purposes but this is the only exception. The core unit shall seal to the tank deck with a stainless steel latch assembly. The latch assembly must be actuated utilizing a single quick release mechanism requiring no more than a half turn of a wrench. The watertight integrity of each core unit shall be established by a 100 percent factory test at a minimum of 5 PSIG.

2.10 CONTROLS

All necessary motor starting controls shall be located in the cast iron enclosure of the core unit secured by stainless steel fasteners. Locating the motor starting controls in a plastic enclosure is not acceptable. The wastewater level sensing controls shall be housed in a separate enclosure from motor starting controls. The level sensor housing must be sealed via a radial type seal; solvents or glues are not acceptable. The level sensing control housing must be integrally attached to pump assembly so that it may be removed from the station with the pump and in such a way as to minimize the potential for the accumulation of grease and debris accumulation, etc. The level sensing housing must be a high-impact thermoplastic copolymer over-molded with a thermo plastic elastomer. The use of PVC for the level sensing housing is not acceptable.

Non-fouling wastewater level controls for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air column connected to a pressure switch. The air column shall be integrally molded from a thermoplastic elastomer suitable for use in wastewater and with excellent impact resistance. The air column shall have only a single connection between the water level being monitored and the pressure switch. Any connections are to be sealed radially with redundant O-rings. The level

detection device shall have no moving parts in direct contact with the wastewater and shall be integral to the pump core assembly in a single, readily-exchanged unit. Depressing the push to run button must operate the pump even with the level sensor housing removed from the pump.

All fasteners throughout the assembly shall be 300 Series stainless steel. High-level sensing will be accomplished in the manner detailed above by a separate air column sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. For increased reliability, pump ON/OFF and high-level alarm functions shall not be controlled by the same switch. Float switches of any kind, including float trees, will not be accepted due to the periodic need to maintain (rinsing, cleaning) such devices and their tendency to malfunction because of incorrect wiring, tangling, grease buildup, and mechanical cord fatigue. To assure reliable operation of the pressure switches, each core shall be equipped with a factory installed equalizer diaphragm that compensates for any atmospheric pressure or temperature changes. Tube or piping runs outside of the station tank or into tank-mounted junction boxes providing pressure switch equalization will not be permitted due to their susceptibility to condensation, kinking, pinching, and insect infestation. The grinder pump will be furnished with a 6 conductor 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements with a Factory Installed EMA 6P EQD half attached to it.

2.11 ALARM PANEL

Each grinder pump station shall include a NEMA 4X, UL-listed alarm panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic polyester to ensure corrosion resistance. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components, and creating a secured safety front to allow access only to authorized personnel. The enclosure shall not exceed 10.5" W x 14" H x 7" D, or 12.5" W x 16" H x 7.5" D if certain options are included.

The alarm panel shall contain one 15-amp, double-pole circuit breaker for the pump core's power circuit and one 15-amp, single-pole circuit breaker for the alarm circuit. The panel shall contain a push-to-run feature, an internal run indicator, and a complete alarm circuit. All circuit boards in the alarm panel are to be protected with a conformal coating on both sides and the AC power circuit shall include an auto resetting fuse.

The alarm panel shall include the following features: external audible and visual alarm; push-to-run switch; push-to-silence switch; redundant pump start; and high level alarm capability. The alarm sequence is to be as follows when the pump and alarm breakers are on:

- A. When liquid level in the sewage wet-well rises above the alarm level, the contacts on the alarm pressure switch activate, audible and visual alarms are activated, and the redundant pump starting system is energized.
- B. The audible alarm may be silenced by means of the externally mounted, push-to-silence button.
- C. Visual alarm remains illuminated until the sewage level in the wet-well drops below the "off" setting of the alarm pressure switch.

The visual alarm lamp shall be inside a red, oblong lens at least 3.75" L x 2.38" W x 1.5" H. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the bottom of the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure (push-to-silence button).

The entire alarm panel, as manufactured and including any of the following options shall be listed by Underwriters Laboratories, Inc.

Service Equipment/Main Service Disconnect Breaker – A separate, internal breaker rated and approved for use as “service equipment” and acts as a main service disconnect of the grinder pump station shall be provided.

DUPLEX STATIONS

Each grinder pump station shall include a NEMA 4X, UL-listed alarm panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic to ensure corrosion resistance. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components, and creating a secured safety front to allow access only to authorized personnel. The standard enclosure shall not exceed 12.5" W x 16" H x 7.5" D.

The panel shall contain one 15-amp single pole circuit breaker for the alarm circuit and one 15-amp double pole circuit breaker per core for the power circuit. The panel shall contain a push-to-run feature, an internal run indicator, and a complete alarm circuit. All circuit boards in the alarm panel are to be protected with a conformal coating on both sides and the AC power circuit shall include an auto resetting fuse.

The visual alarm lamp shall be inside a red, oblong lens at least 3.75" L x 2.38" W x 1.5" H. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the bottom of the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure (push-to-silence button).

The high-level alarm system shall operate as follows:

- A. The panel will go into alarm mode if either pump's alarm switch closes. During the initial alarm mode both pumps will run and the alarm light and buzzer will be delayed for a period of time based on user settings (default is 3-1/2 minutes). If the station is still in high-level alarm after the delay, the light and buzzer will be activated.
- B. The audible alarm may be silenced by means of the externally mounted push-to-silence button.
- C. The visual alarm remains illuminated until the sewage level in the wet well drops below the “off” setting of the alarm switch for both pumps.

The entire alarm panel, as manufactured and including any of the following options shall be listed by Underwriters Laboratories, Inc.

Service Equipment/Main Service Disconnect Breaker – A separate, internal breaker rated and approved for use as “service equipment” and acts as a main service disconnect of the grinder pump station shall be provided.

2.12 SERVICEABILITY

The grinder pump core, including level sensor assembly, shall have two lifting hooks complete with lift-out harness connected to its top housing to facilitate easy core removal when necessary. The level sensor assembly must be easily removed from the pump assembly for service or replacement. All mechanical and electrical connections must provide easy disconnect capability for core unit removal and installation. Each EQD half must include a water-tight cover to protect the internal electrical pins while the EQD is unplugged. A pump push-to-run feature will be provided for field trouble shooting. The push-to-run feature must operate the pump even if the level sensor assembly has been removed from the pump assembly. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

2.13 OSHA CONFINED SPACE

All maintenance tasks for the grinder pump station must be possible without entry into the grinder pump station (as per OSHA 1910.146, permit-required confined spaces). “Entry means the action by which a

person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space."

2.14 SAFETY

The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump station shall be listed by Underwriters Laboratories, Inc. to be safe and appropriate for the intended use. UL listing of components of the station, or third-party testing to UL standard are not acceptable.

The grinder pump shall meet accepted standards for plumbing equipment for use in or near residences, shall be free from noise, odor, or health hazards, and shall have been tested by an independent laboratory to certify its capability to perform as specified in either individual or low pressure sewer system applications. As evidence of compliance with this requirement, the grinder pump shall bear the seal of NSF International. Third-party testing to NSF standard is not acceptable.

PART 3 – EXECUTION

3.01 FACTORY TEST

Each grinder pump shall be submerged and operated for 1.5 minutes (minimum). Included in this procedure will be the testing of all ancillary components such as, the anti-siphon valve, check valve, discharge assembly and each unit's dedicated level controls and motor controls. All factory tests shall incorporate each of the above listed items. Actual appurtenances and controls which will be installed in the field shall be particular to the tested pump only. A common set of appurtenances and controls for all pumps is not acceptable. Certified test results shall be available upon request showing the operation of each grinder pump at two different points on its curve. Additional validation tests include: integral level control performance, continuity to ground and acoustic tests of the rotating components.

The Engineer reserves the right to inspect such testing procedures with representatives of the Owner, at the Grinder Pump Manufacturer's facility.

3.02 DELIVERY

All grinder pump units will be delivered to the job site 100 percent completely assembled, including testing, ready for installation. Field installation of the pump in tanks under 96 inches is not allowed. Field installation of the level sensor into the tank is not allowed. Grinder pump stations will be individually mounted on wooden pallets.

3.03 INSTALLATION

Earth excavation and backfill are specified under site work, but are also to be done as a part of the work under this section, including any necessary sheeting and bracing.

The Contractor shall be responsible for handling ground water to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding.

The grinder pump stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Engineer.

Remove packing material. User's instructions MUST be given to the Owner. Hardware supplied with the unit, if required, will be used at installation. The basin will be supplied with a standard 4" inlet grommet

(4.50" OD) for connecting the incoming sewer line. Appropriate inlet piping must be used. The basin may not be dropped, rolled or laid on its side for any reason.

Installation shall be accomplished so that 1" to 4" of access way, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor.

A 6" inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit.

A concrete anti-flotation collar, as detailed on the drawings, and sized according to the Manufacturer's instructions, shall be required and shall be pre-cast to the grinder pump or poured in place. Each grinder pump station with its pre-cast anti-flotation collar shall have a minimum of three lifting eyes for loading and unloading purposes.

If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured.

The Contractor will fully connect the property owner's existing gravity sewer lateral to the grinder pump station in accordance with the contract documents.

The electrical enclosure shall be furnished, installed and wired to the grinder pump station by the Contractor. An alarm device is required on every installation, there shall be **NO EXCEPTIONS**. It will be the responsibility of the Contractor and the Engineer to coordinate with the individual property owner(s) to determine the optimum location for the Alarm Panel.

The Contractor shall mount the alarm device in a conspicuous location, as per national and local codes. The alarm panel will be connected to the grinder pump station by a length of 6-conductor type TC cable as shown on the contract drawings. The power and alarm circuits must be on separate power circuits. The grinder pump stations will be provided with 32', 25' of useable, electrical supply cable to connect the station to the alarm panel. This cable shall be supplied with a Factory Installed EQD half to connect to the mating EQD half on the core.

3.04 BACKFILL REQUIREMENTS

See Section 02300 Earthwork for Backfill and Bedding material requirements.

3.05 START-UP AND FIELD TESTING

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

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

The services of a trained factory-authorized technician shall be provided at a rate of 40 hours for every 100 grinder pump stations supplied.

Upon completion of the installation, the authorized factory technician(s) will perform the following test on each station:

- A. Make certain the discharge shut-off valve in the station is fully open.
- B. Turn ON the alarm power circuit and verify the alarm is functioning properly.
- C. Turn ON the pump power circuit. Initiate the pump operation to verify automatic "on/off" controls are operative. The pump should immediately turn ON.
- D. Consult the Manufacturer's Service Manual for detailed start-up procedures.

Upon completion of the start-up and testing, the Manufacturer shall submit to the Engineer the start-up authorization form describing the results of the tests performed for each grinder pump station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and any installation deficiencies corrected.

3.06 OPERATION AND MAINTENANCE

MANUALS

The Manufacturer shall supply four copies of Operation and Maintenance Manuals to the Owner, and one copy of the same to the Engineer.

END OF SECTION

SECTION 11306 – GRINDER PUMP STATIONS (CENTRIFUGAL TYPE PUMPS)

PART 1 – GENERAL

1.01 GENERAL DESCRIPTION

The Manufacturer shall furnish complete factory-built and tested Grinder Pump Station(s), each consisting of grinder pump(s) suitably mounted in a basin constructed of wound fiberglass or roto-molded plastic with dimensions and capacities as show on the Contract Drawings, electrical enclosure, pump removal system, PVC discharge assembly/shut-off valve, anti-siphon valve/check valve, each assembled in the basin, electrical alarm panel and all necessary internal wiring and controls. Component type grinder pump systems that require field assembly will not be acceptable due to the potential problems that can occur during field assembly. All components and materials shall be in accordance with Part 2 of this Specification. For ease of serviceability, all pump, motor/grinder units shall be of like type and horsepower throughout the system.

1.02 SUBMITTALS

After receipt of notice to proceed, the Contractor shall furnish a minimum of four sets of shop drawings detailing the equipment to be furnished including dimensional data and materials of construction. The Engineer shall promptly review this data, and return two copies as accepted, or with requested modifications. Upon receipt of accepted shop drawings, the Manufacturer shall proceed immediately with fabrication of the equipment.

1.03 MANUFACTURER

- A. Grinder pump stations, complete with all appurtenances, form an integral system, and as such, shall be supplied by one grinder pump station Manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The Manufacturer shall provide, upon request, a reference and contact list from ten of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification.
- B. The Manufacturer shall be experienced in design and manufacture of grinder pump and grinder pump motor equipment and accessories including grinder pump installations for a minimum of 10 years and 100,000 installed pumps in the United States. Grinder pumping equipment shall be one of the following:
 - 1. Liberty (basis of design)
 - 2. Franklin,
 - 3. Barnes, or
 - 4. Engineer Approved Equal
- C. A Manufacturer being named in this specification notwithstanding, all equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this specification. Pre-submittal: Equipment must be conditionally approved by the Engineer in writing at least ten (10) days prior to bid for all substitute Manufacturers in order to be offered for this project. The Engineer shall furnish in writing, via addendum, acceptance or rejection of substitution/alternate submittal. In no case shall equipment be accepted for this project if not approved by the Engineer in writing prior to bid. Conditional approval by the Engineer under this section is based on a general review only and in no way constitutes final approval of equipment, nor waives any requirement of these specifications,

nor relieves the Contractor or Manufacturer of any degree of responsibility for compliance with specific requirements of other portions of these specifications.

1. Provide a list of 10 installations of same pump size and horsepower within 100 miles radius of project side with contacts and phone numbers having at least five years of operation.
2. Provide evidence of manufacturing capability including a list of professional qualifications of personnel and quality control practices.
3. Certify complete compliance without modification of structures, foundations or electrical equipment.
4. The pump Manufacturer supplier shall certify they have a factory authorized repair facility capable of repairing equipment that is labeled UL Listed or FM Approved for pump and motor repair and direct factory service center capable of completely servicing and stocking identical drive units and spare parts for the proposed pumps within 50 miles of the project location.
5. Attention is directed to the fact that the drawings and overall system design are based on a particular piece of equipment from a particular Manufacturer. These specifications are intended to provide guidelines for standard equipment of a recognized Manufacturer who already meets all the requirements of this specification.

1.04 EXPERIENCE CLAUSE

- A. The equipment furnished hereunder shall be the product of a company experienced in the design and manufacture of grinder pumps specifically designed for use in low pressure systems. All Manufacturers proposing equipment for this project shall have at least 10 years of experience in the design and manufacture of units of identical size(s) and performance to the specified units. All Manufacturers proposing equipment for this project must also have not less than 500 successful installations of low pressure sewer systems utilizing grinder pumps of like type to the grinder pumps specified herein. An installation is defined as a minimum of 25 pumps discharging into a common force main which forms a low pressure sewer system. The Contractor proposing alternate equipment shall also submit, as part of the bid schedule, an installation list with contact person(s), phone number(s) and date(s) of at least 10 installations of the type of pump specified herein that have been in operation for at least 10 years.
 1. In lieu of this experience clause, the Contractor of alternate equipment will be required to submit a 5-year performance bond for 100 percent of the stipulated cost of the equipment as bid and as shown in the Bid Schedule. This performance bond will be used to guarantee the replacement of the equipment in the event that it fails within the bond period.

1.05 OPERATING CONDITIONS

The submersible pump shall be capable of handling residential and commercial sewage and grinding it to a fine slurry enabling it to be pumped over long distances in pipelines as small as 1.25" in diameter. Single stage submersible pumps shall have a shut-off head of at least 110 feet and a maximum flow of 50 GPM at 10 feet of total dynamic head. Two-stage submersible pumps shall have a shut-off head of at least 185 feet and a maximum flow of 38 GPM at 10 feet of total dynamic head.

1.06 WARRANTY

The grinder pump Manufacturer shall provide a part(s) and labor warranty on the complete station and accessories, including, but not limited to, the panel for a period of 36 months after notice of Owner's acceptance, but no greater than 27 months after receipt of shipment. Any manufacturing defects found during the warranty period will be reported to the Contractor or Manufacturer by the Owner and will be corrected by the Manufacturer at no cost to the Owner.

The Contractor shall provide a 24 month extended warranty for the pumps from the Manufacturer, transferrable to the homeowner. Contractor shall be responsible for producing and documenting any and all information required by the Manufacturer to transfer the extended warranty to the homeowner following project acceptance. This may include, but is not limited to, coordinating the installation of

particular pumps at a given address based on the pump's serial number or other identification as determined by the Manufacturer for warranty validation.

1.07 WARRANTY PERFORMANCE CERTIFICATION

Manufacturer shall provide with their submittal a Warranty Performance Certification statement executed by the most senior executive officer of the grinder pump Manufacturer, which certifies a minimum of a 36-month warranty. They must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, including all associated labor and shipping fees, and certify that the Manufacturer will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventive maintenance type requirements shall be included in this form as exclusions. These requirements include, but are not limited to, unjamming of grinder mechanism, periodic motor maintenance, and periodic cleaning of liquid level controls. Should the Contractor elect to submit a performance bond in lieu of the experience clause outlined above, this Warranty Performance Certification shall also be used as a criterion to evaluate the Contractor's performance over the warranty period.

PART 2 – PRODUCTS

2.01 CONSTRUCTION

Centrifugal grinder pumps shall be CSA US Certified. The castings shall be constructed of class 25 cast iron. The motor housing shall be oil filled to dissipate heat. Air filled motors shall not be considered equal since they do not properly dissipate heat from the motor. All mating parts shall be machined and sealed with a Buna-N O-ring. All fasteners exposed to the liquid shall be stainless steel. The motor shall be protected on the top side with sealed cord entry plate with molded pins to conduct electricity eliminating the ability of water to enter internally through the cord. The motor shall be protected on the lower side with a dual seal arrangement. The first seal is a double lip seal molded in fluoroelastomer or Buna-N. The second/main seal shall be a unitized graphite impregnated silicon carbide hard face with stainless steel housings and spring.

The upper and lower bearing shall be capable of handling all radial thrust loads. The lower bearing shall have the additional ability to handle the downward axial thrust produced by the impeller and cutters by design of angular contact roller races. The pump housing shall be of concentric design, thereby equalizing the pressure forces inside the housing, which will extend the service life of the seals and bearings. Additionally, there shall be no cutwater in the housing volute in order to discourage the entrapment of flowing debris. The pump shall be furnished with a stainless steel handle having a nitrile grip.

2.02 ELECTRICAL POWER CORD

The submersible pump shall be supplied with 25 feet of multi-conductor power cord. It shall be cord type SJOOW for 1-phase motors, capable of continued exposure to the pumped liquid. The power cord shall be sized for the rated full load amps of the pump in accordance with the National Electric Code. The power cable shall not enter the motor housing directly, but will conduct electricity to the motor by means of a water tight compression fitting cord plate assembly, with molded pins to conduct electricity. This eliminates the ability for water to enter internally through the cord by means of a damaged or wicking cord.

2.03 MOTORS

As a maximum, the motor shall be 2 HP, 3450 RPM, 240 Volt 60 Hertz, 1 Phase. All motors shall be oil filled and class B insulated NEMA B design, rated for continuous duty. Since air filled motors are not capable of dissipating heat as effectively, they shall not be considered equal. At maximum load, the winding temperature shall not exceed 105° C (unsubmerged). Single-phase motors shall be capacitor start/capacitor run and have an integral thermal overload switch in the windings for protecting the motor.

2.04 BEARINGS AND SHAFT

An upper radial and a lower angular contact ball bearing shall be required. The upper bearing shall be a single ball/race type bearing. The lower bearing shall be an angular contact heavy duty ball/race type bearing, designed to handle axial grinder pump thrust loads. Both bearings shall be permanently lubricated by the oil that fills the motor housing. The bearing system shall be designed to enable proper cutter alignment from shut off head to a maximum load at 10 feet of total dynamic head. The motor shaft shall be made of 300 series stainless steel and have a minimum diameter of 0.670".

2.05 SEALS

The pump shall have a dual seal arrangement consisting of a lower and upper seal to protect the motor from the pumping fluid. The lower seal shall be fluoroelastomer or Buna-N molded double lip seal, designed to exclude foreign material away from the main upper seal. The upper seal shall be a unitized graphite impregnated silicon carbide hard face seal with stainless steel housings and spring equal to Crane Type T-6a. The motor plate/housing interface shall be sealed with a Buna-N O-ring.

2.06 IMPELLER

The impeller shall be an investment cast stainless steel impeller, with pump out vanes on the back shroud to keep debris away from the seal area. It shall be keyed and bolted to the motor shaft.

2.07 CUTTER MECHANISM

The cutter and plate shall consist of 440 stainless steel with a Rockwell C hardness of 55-60. The stationary cutter plate shall have specially designed orifices through it, which enable the slurry to flow through the pump housing at an equalized pressure and velocity. The stationary cutter shall consist of V shapes to maximize cutting action and arc shape exclusion slots to outwardly eject debris from under the rotary cutter. The rotary cutter shall have four (4) blades and be designed with a recessed area behind the cutting edge to prevent the accumulation and binding of any material between rotary cutter and the stationary cutter. The cutting system must incorporate close tolerances for optimum performance. Ring or radial cutters, or those that grind on the outside circumference, shall not be considered equal.

2.08 CONTROLS

Automatic units shall be supplied with CSA and UL approved automatic wide angle tilt float switches. Manual pumps are operable by means of a control panel.

2.09 ALARM PANEL

Grinder pump stations equipped with automatic pumping units shall be provided with a NEMA 4X outdoor rated, UL-listed alarm panel suitable for wall or pole mounting. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components and creating a secure safety front to allow access only to authorized personnel.

The alarm panel shall include the following features: external audible and visual alarm; push-to-run switch; push-to-silence switch; redundant pump start; and high level alarm capability. The alarm sequence is to be as follows when the pump and alarm breakers are on:

- A. When liquid level in the sewage wet-well rises above the alarm level, the contacts on the alarm float switch activate, audible and visual alarms are activated, and the redundant pump starting system is energized.
- B. The audible alarm may be silenced by means of the externally mounted, push-to-silence button.

- C. Visual alarm remains illuminated until the sewage level in the wet-well drops below the “off” setting of the alarm pressure switch.

The visual alarm lamp shall consist of flashing red LEDs. Visual alarm shall be mounted to the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the bottom of the enclosure, capable of 95 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the enclosure (push-to-silence button).

The entire alarm panel, as manufactured and including any of the following options shall be listed by Underwriters Laboratories, Inc.

2.12 PAINT

The exterior of the casting shall be protected with powder coat paint.

2.13 SUPPORT

The pump shall have cast iron support legs, enabling it to be a freestanding unit. The legs shall be high enough to allow solids and long stringy debris to enter the cutter assembly.

2.14 SERVICEABILITY

Components required for the repair of the pump shall be shipped within a period of 24 hours.

2.15 FACTORY ASSEMBLED TANK SYSTEMS WITH GUIDE RAIL AND QUICK DISCONNECT DISCHARGE

Factory mounted guide rail system with pump suspended by means of bolt-on quick disconnect that is sealed by means of nitrile grommets. The discharge piping shall be Schedule 80 PVC and furnished with a check valve and PVC shut-off ball valve. The tank shall be wound fiberglass. An inlet hub shall be provided with the system.

PART 3 – EXECUTION

3.01 TESTING

The pump shall have a ground continuity check and the motor chamber shall be hi-potted to test for electrical integrity, moisture content, and insulation defects. The motor and volute housing shall be pressurized and an air leak decay test performed to ensure integrity of the motor housing. The pump shall be run, voltage current monitored, and checked for noise or other malfunction.

The Engineer reserves the right to inspect such testing procedures with representatives of the Owner, at the Grinder Pump Manufacturer’s facility.

3.02 QUALITY CONTROL

The pump shall be manufactured in an ISO 9001 certified facility.

3.03 DELIVERY

All grinder pump units will be delivered to the job site 100 percent completely assembled, including testing, ready for installation. Field installation of the pump in tanks under 96 inches is not allowed. Field installation

of the level sensor into the tank is not allowed. Grinder pump stations will be individually mounted on wooden pallets.

3.04 INSTALLATION

Earth excavation and backfill are specified under site work, but are also to be done as a part of the work under this section, including any necessary sheeting and bracing.

The Contractor shall be responsible for handling ground water to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding.

The grinder pump stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Engineer.

Remove packing material. User's instructions MUST be given to the Owner. Hardware supplied with the unit, if required, will be used at installation. The basin will be supplied with a standard 4" inlet grommet (4.50" OD) for connecting the incoming sewer line. Appropriate inlet piping must be used. The basin may not be dropped, rolled or laid on its side for any reason.

Installation shall be accomplished so that 1" to 4" of access way, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor.

A 6" inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit.

A concrete anti-flotation collar, as detailed on the drawings, and sized according to the Manufacturer's instructions, shall be required and shall be pre-cast to the grinder pump or poured in place. Each grinder pump station with its pre-cast anti-flotation collar shall have a minimum of three lifting eyes for loading and unloading purposes.

If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured.

The Contractor will fully connect the property owner's existing gravity sewer lateral to the grinder pump station in accordance with the contract documents.

The electrical enclosure shall be furnished, installed and wired to the grinder pump station by the Contractor. An alarm device is required on every installation, there shall be **NO EXCEPTIONS**. It will be the responsibility of the Contractor and the Engineer to coordinate with the individual property owner(s) to determine the optimum location for the Alarm Panel.

The Contractor shall mount the alarm device in a conspicuous location, as per national and local codes. The alarm panel will be connected to the grinder pump station by a length of 6-conductor type TC cable as shown on the contract drawings. The power and alarm circuits must be on separate power circuits. The grinder pump stations will be provided with 25' of useable, electrical supply cable to connect the station to the alarm panel.

3.05 BACKFILL REQUIREMENTS

See Section 02300 Earthwork for Backfill and Bedding material requirements.

3.06 START-UP AND FIELD TESTING

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

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

The services of a trained factory-authorized technician shall be provided at a rate of 40 hours for every 100 grinder pump stations supplied.

Upon completion of the installation, the authorized factory technician(s) will perform the following test on each station:

- A. Make certain the discharge shut-off valve in the station is fully open.
- B. Turn ON the alarm power circuit and verify the alarm is functioning properly.
- C. Turn ON the pump power circuit. Initiate the pump operation to verify automatic "on/off" controls are operative. The pump should immediately turn ON.
- D. Consult the Manufacturer's Service Manual for detailed start-up procedures.

Upon completion of the start-up and testing, the Manufacturer shall submit to the Engineer the start-up authorization form describing the results of the tests performed for each grinder pump station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed and any installation deficiencies corrected.

3.07 OPERATION AND MAINTENANCE

MANUALS

The Manufacturer shall supply four copies of Operation and Maintenance Manuals to the Owner, and one copy of the same to the Engineer.

END OF SECTION

SECTION 13350 – ELECTROMAGNETIC FLOWMETER

PART 1 – GENERAL

1.01 SUMMARY

- A. This section describes the requirements for an electromagnetic flow meter and microprocessor- based signal converter. Under this item, the contractor shall furnish and install the magmeter equipment and accessories as indicated on the plans and as herein specified.

1.02 SUBMITTALS

- A. The following information shall be included in the submittal for this section:
 - 1. Data sheets and catalog literature for the sensor and the microprocessor-based signal transmitter.
 - 2. Connection diagrams for equipment wiring.
 - 3. List of spare parts and optional equipment.

PART 2 – PRODUCTS

2.01 PRODUCTS

- A. Electromagnetic Flowmeter (Maggmeter)
 - 1. The electromagnetic flow meter shall consist of a flow sensor, type FMS500, based on Faraday's Law of Electromagnetic Induction and microprocessor-based signal transmitter, type FMT020.
 - 2. Sensor:
 - a. Operating principle: Utilizing Faraday's Law of Electromagnetic Induction, the flow of liquid through the sensor induces an electrical voltage that is proportional to the velocity of the flow.
 - b. Construction:
The sensor flow tube and liner material shall be constructed of a composite elastomer (hard and soft rubber) surrounded by two integral coils. Measurement and grounding electrodes shall be 316 stainless steel. Connecting flanges shall be carbon steel.
 - c. Installation: A minimum of 5 pipe diameters up stream and 3 pipe diameters down stream are recommended (Consult the factory for any variations.). Zero up and zero down installation capabilities.
 - d. Operating Temp: -4 to +158° F.
 - e. Size: 4" diameter
 - f. Submergence: The sensor shall be pedestal sealed against accidental submersion to 3 feet for 30 minutes standard or permanently submerged to 30 feet when the terminal box is backfilled with a non-setting, transparent potting material.
 - 3. Transmitter:
 - a. Type FMT020.
 - b. Enclosure: IP66/67, NEMA 4X/6
 - c. Display: Background illumination with alphanumeric 4-button HMI, menu driven display to indicate flow rate, totalized values, settings, and faults (a blind version of the FMT020 signal transmitter is available).
 - d. Power supply: 100-240 VAC, 12-42 VDC.
 - e. Operating temperature: -5 to +120 degrees F.
 - f. Outputs: 0-20 mA or 4-20 mA into 800 ohms max. One relay rated at 42 VAC/2 A, 24 DC/1 A. Digital (frequency or pulse) for external display of flow rate or totalizer.
 - g. Communications: HART, EtherNet/IP, MODBUS RTU, MODBUS TCP/IP, PROFINET.
 - h. Sensor and transmitter performance:
 - i. Flow Range: 1.5 fps to 33 fps for accuracies stated below.
 - ii. Accuracy: 0.2% of actual flow.

- iii. Separation: Maximum distance of 900 feet between transmitter and sensor without the use of any additional equipment.
 - iv. Bi-directional flow capabilities shall be standard
 - i. Totalizer: Two eight-digit counters for forward, net, or reverse flow
 - j. The electromagnetic flow meter shall be a Siemens Model FMS500 flow sensor with a Siemens Model FMT020 signal transmitter. Insertion type flow meters will not be accepted.
4. Spare Parts
- a. Spare parts for the equipment shall include the following, unless otherwise noted:
 - i. One set of manufacturers recommended spare parts.
 - ii. Coil Sealing Compound
 - iii. Extra operation manuals as required.

2.02 OPERATOR FUNCTIONS

A. Calibration

- 1. Each flow sensor shall be wet calibrated and all of the calibration information and factory settings matching the sensor shall be stored in an integrally mounted SENSORPROM® memory unit. The SENSORPROM® shall store sensor calibration data and signal converter settings for the lifetime of the product. At initial commissioning, the flowmeter commences measurement without any initial programming. Any customer specified settings are downloaded to the SENSORPROM®. Should the transmitter need to be replaced, the new transmitter will upload all previous settings and resume measurement without any need for reprogramming or rewiring.
- 2. A certificate of calibration shall accompany each flow sensor.

B. Signal Transmitter Function Details

- 1. The following functions shall be provided:
 - a. All programming shall be accomplished through an integral keypad and all programming shall be protected by a user-defined password.
 - b. The transmitter shall be remotely mounted using a remote- mount kit provided by the manufacturer inside the control panel for the lift station.
 - c. The transmitter shall provide a 0/4-20 mA DC signal proportional to flow rate into 800 ohms max. Output selectable as unidirectional or bi-directional.
 - d. The relay shall be programmable as error indicator, limit alarm or pulsed output.
 - e. The signal transmitter system shall be equipped with an error and status log with 4 groups of information.
 - i. Information without a functional error involved.
 - ii. Warnings which may cause malfunction in the application
 - iii. Permanent errors, which may cause malfunction in the application.
 - iv. Fatal error, which is essential for the operation of the flowmeter.
 - f. A system error shall be indicated by a flashing icon on the display or activation of the relay when set as an error alarm.
 - g. The first nine standing errors shall be stored in the error pending log. A corrected error is removed from the error pending log. A status log shall be provided to store the last 9 error messages received for 180 days regardless of correction.

C. Verification

- 1. Verification using a stand-alone Siemens Vericator, or equivalent, to measure a number of selected parameters in the flow sensor and signal converter, which affects the integrity of the flow measurement, shall be available through a factory verification service.

D. Parameters

- 1. Verification of the Flowmeter shall consist of the following test routines:
 - a. Insulation test of the entire flowmeter system and cables.
 - b. Test of sensor magnetic properties.

- c. Signal transmitter gain, linearity, and zero point tests.
 - d. Digital output test.
 - e. Analog output test.
- E. Certificate
 - 1. A certificate of verification shall be issued if the flowmeter passes all of the tests with-in 1% of the original factory test parameters.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation
 - 1. Follow manufacturer's recommendation for the minimum upstream and downstream installation requirements for the flow sensor.
 - 2. Wiring between flow sensors and remote mounted signal converters shall use cable type and procedures as per the manufacturers' recommendations.
 - 3. During the lift station startup day, a factory authorized technician shall calibrate and sign off on the installed flowmeter, to confirm that it was installed in accordance with the manufacturer's recommendations, and also to confirm that it is accurately reporting flows.

3.02 MANUFACTURER'S ASSISTANCE

- A. Warranty
 - 1. The manufacturer of the electromagnetic flow meter shall guarantee for one year of operation that the equipment shall be free from defects in design, workmanship, or materials.
 - 2. In the event a component fails to perform as specified, or is proven defective in service during the guarantee period, the manufacturer shall promptly repair or replace the defective part at no cost to the owner.

END OF SECTION

SECTION 13351 – GRAVITY FLOW METER

PART 1 – GENERAL

1.01 SUMMARY

- A. This section describes the requirements for an area velocity flow meter and associated equipment. Under this item, the contractor shall furnish and install the area velocity flow meter equipment and accessories as indicated on the plans and as herein specified.

1.02 SUBMITTALS

- A. The following information shall be included in the submittal for this section:
 - 1. Data sheets and catalog literature for the area velocity flowmeter and associated equipment.
 - 2. Connection diagrams for equipment wiring.
 - 3. List of spare parts and optional equipment.

PART 2 – PRODUCTS

2.01 PRODUCTS

- A. Area Velocity Flowmeter
 - 1. Flow measurement technology supplied by Teledyne Isco, 4700 Superior Street, Lincoln, NE, 68504-1398. Phone (402) 464-0231, fax (402) 465-3064, email: IscoInfo@teledyne.com, web site: www.isco.com.
- B. The LaserFlow Sensor shall be a Class 3R Laser Product.
- C. Sensor Construction
 - 1. The LaserFlow will be constructed of conductive carbon filled ABS plastic, SST, conductive Kynar (ultrasonic sensor), anodized aluminum (ultrasonic housing), and UV-rated PVC (cable jacket).
 - 2. The LaserFlow enclosure shall be rated IP68 (Submerged @ 2 m depth for 72 hrs).
 - 3. The LaserFlow shall be certified CE EN61326; FDA CDRH; 21CFR1040; IEC 60825-1.
 - 4. Standard cable length shall be 5, 10, 15, or 23 m (16.4, 32.8, 49.2, or 75.5 ft).
 - 5. The LaserFlow sensor shall have a carrying handle that can lock the sensor in place on optional mounting hardware for either permanent or temporary installations.
- D. Input voltage supplied by the connected flow meter or module shall be within the range of 8 to 26 volts DC, 12 volts DC nominal.
- E. Optionally, stainless steel mounting hardware shall be supplied for physical installation.¹
- F. Optionally, a sensor retrieval tool with maximum extension of 23 feet shall be supplied for retrieval and installation from above ground.²
- G. Laser Doppler Operation
 - 1. The laser velocimeter will use a laser beam to generate a source frequency light focused at points below the surface of the flow stream. The source light and shifted reflected light frequencies will be modulated to determine a Doppler shift, which will then be used to calculate flow stream velocity.

¹ Specify optional mounting hardware.

² Specify optional retrieval arm.

2. The LaserFlow shall be able to move the laser beam horizontally and focus at different depths in order to obtain readings at 1 to 15 specified points in the flow, with automatic compensation to maintain precise focus at all times, to obtain an average velocity measurement.
- H. Ultrasonic Operation
 1. The ultrasonic level sensor will consist of a single ultrasonic 50KHz transducer mounted on the bottom of the LaserFlow device.
 2. The ultrasonic level sensor will include a temperature probe to automatically compensate for air temperature changes.
 3. The ultrasonic level sensor will automatically adjust its gain in response to echo strength to maximize performance in the presence of steam, foam, and turbulence.
- I. Spare Parts
 1. Spare parts for the equipment shall include the following, unless otherwise noted:
 - a. One set of manufacturers recommended spare parts.
 - b. Extra operation manuals as required.

2.02 OPERATOR FUNCTIONS

- A. The LaserFlow will measure flow stream velocity below the liquid surface by means of non-contact, laser Doppler technology, while mounted above the stream.³
 1. The number of subsurface velocity measurements shall be programmable in the field between 1 and 15.
 2. The laser velocity measurement range will be -4.6 m/s to 4.6 m/s (-15 ft/s to 15 ft/s).
 3. The laser velocity measurement accuracy will be $\pm 0.5\%$ of reading ± 0.03 m/s (0.1 ft/s).
 4. Where appropriate, the device shall be capable of bi-directional velocity measurement where turbidity > 20 NTU and distance from liquid surface to bottom of sensor < 48 inches.
 5. Minimum flow velocity for measurement will be 0.25 m/s (0.8 ft/s).
- B. The LaserFlow will measure flow stream level by means of non-contact, ultrasonic technology, while mounted above the stream.
 1. The ultrasonic level measurement range (from sensor face to liquid surface) will be 0.0 to 3.0m (1 to 10ft).
 2. Ultrasonic level measurement accuracy at 22°C (72°F) will be: ± 0.006 m (0.02 ft) at ≤ 1 ft level change; ± 0.012 m (0.04 ft) at > 1 ft level change.
 3. The ultrasonic sensor beam angle will be 10° (5° from center line).
 4. The temperature coefficient within compensated range will be $\pm 0.00011 \times \text{Distance (ft)} \times \text{temperature deviation from } 72^\circ\text{F}$ ($\pm 0.0002 \times \text{Distance (m)} \times \text{temperature deviation from } 22^\circ\text{C}$).
- C. The LaserFlow will have a flow accuracy of $\pm 5\%$ of reading, typical under normal conditions.
- D. Non-contact level and velocity measurement shall have zero deadband from the bottom of the sensor to the liquid surface.
- E. The LaserFlow will transmit flow stream velocity and level data to a Teledyne Isco Signature™ Series Flow Meter, or to a Teledyne Isco 2160 Laser Module, using Teledyne Isco proprietary protocol.
- F. The LaserFlow system shall optionally be capable of uninterrupted measurement when submerged, by means of submerged continuous wave ultrasonic Doppler velocity measurement, and submerged differential pressure transducer level measurement.⁴

³ Patent Pending

⁴ Specify optional submerged measurement functionality.

- G. The LaserFlow system shall optionally be capable of redundant flow measurement, by means of submerged continuous wave ultrasonic Doppler velocity measurement.⁵
- H. Temperature
 - 1. Operating temperature range shall be 32 to 140°F (0 to 60°C).
 - 2. Storage temperature range shall be -40 to 140°F (-40 to 60°C).

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation
 - 1. Follow manufacturer's recommendation for the installation requirements.
 - 2. Wiring between all devices shall use cable type and procedures as per the manufacturers' recommendations.

3.02 MANUFACTURER'S ASSISTANCE

- A. Warranty
 - 1. The manufacturer of the area velocity flow meter shall guarantee for one year of operation that the equipment shall be free from defects in design, workmanship, or materials.
 - 2. In the event a component fails to perform as specified, or is proven defective in service during the guarantee period, the manufacturer shall promptly repair or replace the defective part at no cost to the owner.

END OF SECTION

⁵ Specify optional redundant flow measurement.

SECTION 13360 – RAIN GAUGES

PART 1 – GENERAL

1.01 SUMMARY

- A. This section describes the requirements for a tipping-bucket style rain gauge. Under this item, the owner shall furnish and the contractor install the rain gauge as indicated on the plans and as specified herein.

1.02 SUBMITTALS

- A. The following information shall be included in the submittal for this section:
 - 1. Data sheets and catalog literature for the Rain Gauge.
 - 2. Connection diagrams for equipment wiring.
 - 3. List of spare parts and optional equipment.

PART 2 – PRODUCTS

2.01 SUMMARY

- A. Rain Gauge
 - 1. The rain gauge shall be Catalog #52202 from RM Young Co.
 - 2. Specifications:
 - a. Size: 18 cm dia. x 30 cm high, (39 cm high with mounting base)
 - b. Catchment Area: 200 cm²
 - c. Resolution: 0.1 mm per tip
 - d. Accuracy: 2% up to 25 mm/hr 3% up to 50 mm/hr
 - e. Output: Magnetic reed switch (N.O.), rating 24VAC/DC 500mA
 - f. Operating Temperature: -20°C to +50°C (heated)
 - 3. Power: 18 Watts for heater only
 - a. Mounting: Clamp for 1" (1.34" dia.) iron pipe or 3 bolts on 160mm dia. circle
 - b. Other: Leveling adjustment, thermostatic control for heater, intake screen

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation
 - 1. Rain Gauge to be installed at Lift Station 1 only.
 - 2. Follow manufacturer's recommendation for the installation of the rain gauge.
 - 3. Wiring between the rain gauge and the PLC shall use cable type and procedures as per the manufacturers' recommendations.

3.02 MANUFACTURING

- A. Warranty
 - 1. The manufacturer of the electromagnetic flow meter shall guarantee for one year of operation that the equipment shall be free from defects in design, workmanship, or materials.
 - 2. In the event a component fails to perform as specified, or is proven defective in service during the guarantee period, the manufacturer shall promptly repair or replace the defective part at no cost to the owner.

END OF SECTION

SECTION 16010 – ELECTRICAL WORK

PART 1 – GENERAL

1.01 SUMMARY

- A. Electrical work can be generally summarized, but not limited to, the following:
 - 1. Complete installation of wiring and other electrical systems as indicated in the drawings and these specifications.
- B. Systems to be Installed:
 - 1. 277/480 V, 3-phase, 60 Hertz, 4-wire power system.
 - 2. 120/240 V, single-phase, 60 Hertz, 3-wire lighting and power system.
 - 3. Grounding systems.
 - 4. Control Systems.
 - 5. Underground conduit system, as required by drawings.
 - 6. Temporary lighting and convenience power facilities during construction.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Only reasonably perfect, new materials of the best design, manufacture, quality, and workmanship, free from defects, deterioration, abuse, mishandling, or neglect shall be used in this electrical installation. Industrial or specification grade materials are to be used throughout. Materials damaged or deteriorated from any cause, whatsoever, will not be permitted and shall not be used.
- B. Materials, including their component parts, used in this electrical installation shall conform to the rules and standards, both mandatory and recommendatory, of the NEC (NFPA 70, 2017 Edition) for their application.
- C. Materials that are similar as to construction, type, or use, shall be uniform as to appearance, make, and type throughout the electrical installation.

PART 3 – EXECUTION

3.01 TESTING

- A. Test all electrical equipment upon completion of installation to ensure that the equipment operates satisfactorily and to conform to Contract documents.
- B. Coordinate installation of equipment and wiring with the established construction schedule as required by Division 1.

3.02 COORDINATION AND SCHEDULING

- A. Delay installation of exposed conduit, lighting fixtures, or other equipment until all piping, pipe hangers, ducts, and equipment which are above have been installed, unless written release is given by the Engineer for specific cases.
- B. Coordinate installation of equipment and wiring with the established construction schedule as required by Division 1.

END OF SECTION

SECTION 16120 – CONDUCTORS AND CABLE

PART 1 – GENERAL

1.01 SUMMARY

- A. Extent of conductor and cable work is indicated by drawings and schedules.

1.02 SUBMITTALS

- A. Submit compliance submittals in accordance with Division 1.
- B. Submit manufacturer's data on electrical conductors, cables, connectors, and splices.

1.03 QUALITY ASSURANCE

- A. National Electrical Code (NEC): Comply with NEC requirements as applicable to construction, installation and color coding of electrical conductors and cables.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver conductor and cable properly packaged in factory-fabricated type containers or wound on NEMA-specified type conductor and cable reels.
- B. Store conductors and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle conductor and cable carefully to avoid abrading, puncturing, and tearing insulation and sheathing. Ensure that dielectric resistance integrity of conductors/cables is maintained.

PART 2 – PRODUCTS

2.01 CONDUCTORS AND CABLES

- A. General: Provide stranded electrical conductors, cables, and connectors of manufacturer's standard materials, as indicated by published product information, designed, and constructed as recommended by manufacturer, for a complete installation, and for application indicated.
- B. Conductors: Provide factory-fabricated stranded conductors of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper conductor selection as determined by the installer to comply with project's installation requirements, NEC and NEMA standards.

2.02 CABLE IDENTIFICATION

- A. Nylon ties with identification tab:
 - 1. Thomas and Betts "Ty-Rap" or Panduit "Sta-Strap."
 - 2. Heat stamp conduit number on identification tab or mark with pen using nylon marking ink.
 - 3. If heat stamped, fill designations with black paint on natural nylon and white paint on colored tags.

2.03 CONDUCTOR MARKERS

- A. Vinyl cloth self-sticking with clear vinyl protective shield or heat-shrink type.

- B. Black printed numbers or letters on white background.
- C. Markers to be oriented on conductors to facilitate convenient reading of markings.

PART 3 – EXECUTION

3.01 INSTALLATION OF CONDUCTORS AND CABLES

- A. General:
 - 1. Coordinate conductor/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of conductors/cables with other work.
 - 2. Pull conductors simultaneously where more than one is being installed in the same raceway.
 - 3. Use pulling compound or lubricant, where necessary. Compound used must not deteriorate conductor or insulation. Soap cannot be used as a pulling lubricant.
 - 4. Use pulling means including, fish tape, cable, rope, and basket weave conductor/cable grips which will not damage cables or raceway.
 - 5. Install exposed cable parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.
 - 6. Keep conductor splices to a minimum.
 - 7. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.
 - 8. Use splice and tape connectors which are compatible with conductor material.
 - 9. Tighten electrical connectors and terminals, including screws and bolts in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.
- B. Power (600volts and below), Control, Instrument, and Specialty Cable:
 - 1. Install in conduit, duct, wireway, or cable tray as indicated or specified.
 - 2. Install metallic barrier in all tray and boxes to separate instrumentation from power and control circuits where run in the same tray or box.
 - 3. Install complete as indicated and as recommended by manufacturer.
 - 4. Install continuous between terminal points indicated without intermediate splices or taps unless otherwise approved by the Engineer.
 - 5. Make splices only in junction or terminal boxes. For control and instrument cables, splices shall be made on terminal blocks with marking strips. Maintain color coding on all splices. For power cable 6 AWG and smaller, splices shall be made on terminal blocks. For power cables larger than 6 AWG, splices shall be made using Crimp type connectors and taped.
 - 6. Do not subject cable to pulling tension exceeding manufacturer's recommendations.
 - 7. Attach pulling grips over the cable sheath to prevent slipping the insulation.
 - 8. Install cable supports in vertical runs of conduit, at boxes and at terminations in equipment, and as required to meet the intermediate support requirements of the NEC.
 - 9. Secure with cable ties in cable tray risers at intervals not exceeding 3 feet.
 - 10. Tie together with cable ties all single conductor cable on each individual circuit in each junction box, equipment, or manhole, and in cable tray, at intervals not to exceed 6 feet.
 - 11. Clamp, snub, and tie for proper support at each terminal block or connection so that any strain on the cable will not be transferred to the terminal connections.
 - 12. Do not tie conductors from different cables together.
 - 13. Tag each individual conductor or conductor with wire markers as follows:
 - (a) With terminal designation indicated on schematic diagrams or given on manufacturer's equipment drawings.
 - (b) At each terminal.

(c) In addition to specified circuit tags.

14. Terminate and ground, control, instrument, and specialty cable shields as indicated and recommended by the manufacturer of the equipment being connected. In general, ground the shields at the control boards for control cables and at the receiving end equipment for instrumentation and specialty cables.

C. Cable Connections and Terminations:

1. Make up clean and tight to assure a low-resistance joint.
2. Make only in terminal boxes, equipment, or other accepted enclosures and not in conduit.
3. Install connectors with tooling manufactured by the connector manufacturer. Tooling shall be equal to AMP Special Industries, having die or piston stops to prevent over crimping and CERTI-CRIMP feature or DYNA-CRIMP pressure relief feature to prevent under crimping. The dies of all application tooling shall provide dot or conductor size coding for quality control verification.

3.02 FIELD QUALITY CONTROL

- A. Provide manufacturer's field services as specified in Division 1.
- B. Field testing as specified in this Division.

END OF SECTION

SECTION 16150 – MOTORS AND ACCESSORIES

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. The extent of motors and drives is indicated by drawings and schedules. This is a standard division on motors, accessories and variable-speed drives and may contain specifications for motors or devices not actually used on this contract.
- B. Types of motors, accessories and variable-speed drives in this section include the following:
 - 1. Horizontal single-phase motors
 - 2. Horizontal polyphase motors
 - 3. Large horizontal polyphase motors
 - 4. Vertical polyphase motors
 - 5. Submersible motors
 - 6. Belt guards
 - 7. Couplings
 - 8. Belt drives

1.02 RELATED DOCUMENTS

- A. This section is a Division 16 Basic Electrical Materials and Methods section and is a part of each division referring to motors and accessories.

1.03 SUBMITTALS

- A. Submit Compliance submittals in accordance with Division 1.
- B. Include but not limited to the following:
 - 1. Nameplate information consisting of the following:
 - a. Manufacturer's name and serial number.
 - b. Horsepower output.
 - c. Temperature rise and method indicated.
 - d. Maximum ambient temperature.
 - e. Insulation class.
 - f. RPM and rated load.
 - g. Frequency
 - h. Number of phases.
 - i. Voltage
 - j. Rated load amperes.
 - k. Locked rotor amperes or code letter.
 - l. Service factor
 - m. Maximum noise level of pump/motor unit (dBA).
 - n. Efficiency
 - 2. Dimensions for enclosure and shafts
 - 3. Weight
 - 4. Bearing information.
 - 5. Schematic and wiring diagrams for variable frequency drives and controls.
 - 6. In addition, installation drawings shall be furnished with information such as weights, lifting instructions, storage instructions, mounting data, ventilation requirements, locations of electrical connections, location and sizes of ground terminations, location and recommended use of shielded wire where required.

7. Electrical drawings and instruction manuals shall include connection data to permit removal and installation of recommended smallest replaceable units.

1.04 QUALITY ASSURANCE

- A. National Electrical Code (NEC): Comply with NEC as applicable to installation and wiring of motors and capacitors.
- B. Anti-Friction Bearing Manufacturers Association (AFBMA): Comply with applicable requirements pertaining to bearings.
- C. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements of IEEE Std 112, "Test Procedures for Polyphase Induction Motors and Generators."
- D. National Electrical Manufacturers' Association (NEMA): Comply with applicable portions of NEMA Stds Pub/No. MG1 "Motors and Generators."
- E. National Safety Council
- F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Comply with applicable portions of Low-Velocity Duct Material.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide equipment of one of the following manufacturers:
 1. Motors:
 - a. Electric Machinery Manufacturing Company.
 - b. General Electric Company.
 - c. Ideal Electric and Manufacturing Company.
 - d. Louis-Allis Company, Division of Litton Industries.
 - e. Marathon Electric Manufacturing Corporation.
 - f. Siemens-Allis, Inc.
 - g. U.S. Motors Division, Emerson Electric Company.
 - h. Westinghouse Electric Corporation.
 - i. Or approved equal.
 2. Couplings:
 - a. Thomas Coupling Division of Rex Chainbelt, Inc.
 - b. Waldron-Hartig Machinery Division, Midland-Ross Corporation.
 - c. Or approved equal.
 3. Adjustable Motor Pulley:
 - a. Gates Rubber Company.
 - b. Browning Manufacturing Division, Emerson Electric Company.
 - c. Square D.
 - d. Or approved equal.

2.02 EQUIPMENT AND MATERIALS

- A. Horizontal Single-Phase Motors:
 1. Rated for 40degrees C ambient temperature and continuous operation.
 2. Voltage: 115V or 115/230V, 60Hz.
 3. Maximum speed: 1800rpm unless indicated or specified otherwise.
 4. Minimum service factor

- a. 1.15 for open, drip-proof enclosures
 - b. 1.0 for totally closed enclosures
 5. Permanent split capacitor designed for low starting torque loads and applications requiring silent operations.
 6. Capacitor start designed for high starting torque loads.
 7. Adequate to drive equipment over the full operating range without exceeding service factor.
 8. Bearings as specified in Horizontal Polyphase Motors, this Section.
 9. Open drip-proof enclosures for clean dry atmospheres and totally enclosed enclosures for wet or dirty atmospheres.
 10. Nameplate on enclosure with all lubrication and electrical data.
- B. Horizontal Polyphase Motors:
 1. Rated for 460-volt, 3-phase, and 60-Hz operation.
 2. Squirrel cage induction type for across-the-line or reduced-voltage starting as indicated.
 3. NEMA Design:
 - a. NEMA B: Normal starting duty applications.
 - b. NEMA C: High starting duty applications.
 4. NEMA Class B insulation except for installation where NEMA Class F is recommended by the manufacturer for the application.
 5. Enclosures: Open drip-proof for indoor service, totally enclosed for outdoor service or wet areas, explosion-proof in explosives atmospheres.
 6. Horsepower Rating Requirements: Ambient temperature: 40 degrees C. unless a higher temperature is specified; open drip-proof motors with 1.15 service factor through 200 hp; unity service factor for totally enclosed or explosion proof motors; 1800 rpm unless specified or indicated otherwise; adequate to drive equipment without using service factor except in emergency conditions. Motors shall be designed for use with variable frequency drives where indicated.
 7. Bearings: Pre-lubricated ball bearings shielded to prevent entrance of foreign materials; relubrication fittings and flushing system; minimum bearing life rating of L10 for continuous operation of 50,000 hours to conform to AFBMA; nameplate with all electrical and lubricating information.
 8. Winding heaters shall be provided for motors exposed to outdoor weather conditions.
- C. Vertical Polyphase Motors:
 1. Rated for 460-volt, 3-phase, 60 Hz operation.
 2. Squirrel cage, induction-type across-the-line or reduced-voltage starting as indicated.
 3. Solid or hollow shaft design.
 4. NEMA Design B:
 - a. Minimum starting torque 100 percent of full load.
 - b. Maximum torque greater than 200 percent of full load.
 - c. Maximum starting current 650 percent of full load.
 5. NEMA Class B insulation except for installations where NEMA Class F is recommended by the manufacturer for the application.
 6. NEMA weatherproof Type 1 (WP-1) enclosure unless specified otherwise.
 7. Horsepower Rating Requirements: Ambient temperature: 40 degrees C; temperature rise: 80 degrees C; service factor of 1.15 on WP-1 enclosures and 1.0 on other types; 1800 rpm unless specified or indicated otherwise; adequate to drive equipment without using service factor except in emergency conditions.
 8. Bearings: Designed for static and dynamic, and continuous and momentary thrusts as required by the driven equipment; grease- or oil-lubricated bearings with relubrication fittings and flushing system; antifriction or Kingsbury type; visual level indicator for oil-lubricated bearings; minimum bearing life rating of L10 for continuous operation of 50,000 hours to conform to AFBMA.
 9. Screened openings or other suitable means for safety and protection from rodents or other animals.

10. Stainless-steel nameplate with all electrical and lubrication information.
 11. Drip covers and lifting lugs.
 12. Winding heaters shall be provided for motors exposed to outdoor weather conditions.
- D. Submersible Motors:
1. Vertical squirrel-cage induction type.
 2. NEMA Design B, Class F, insulation.
 3. Rated 460 volts, 3 phase, 60 hertz.
 4. Across-the-line starting or reduced voltage starting as indicated.
 5. Totally enclosed construction suitable for submerged service.
 6. Rating: Ambient temperature: 40 degrees C; 1.15 service factor; speed as specified or indicated for each piece of equipment drive; adequate to drive equipment without using service factor except in emergency conditions; motor shall be designed for continuous duty, capable of sustaining a minimum of ten starts per hour.
 7. Include three disc-type temperature switches imbedded in the starter windings (one per phase) to stop motor on high temperature conditions. Provide seal fail detection system.
 8. Motor data nameplate with all lubrication and electrical data located at each motor starter.
 9. Supply cable for each pump of sufficient length to reach disconnect switch or junction box without splice.
- E. Belt Guards:
1. Fully enclosed belts on both sides except where equipment forms one side.
 2. Size to enclose next larger size driven pulley.
 3. Two-piece construction when driven equipment and motor are on opposite sides of the belt guard.
 4. Provide tachometer holes and covers.
 5. Conform to National Safety Council Code.
 6. Constructed to conform to Figure 3-4 of the SMACNA Low-Pressure Duct Manual.
- F. Coupling:
1. Type as required for specific application as acceptable to Engineer.
 2. Protective guard to conform to National Safety Council Code.
- G. Belt Drivers:
1. Single or multiple V-belt.
 2. Rated 140 percent of motor horsepower.
 3. Adjustable speed with maximum belt speed at 4500 fpm.
 4. Matched sets of belts on multiple belt drives.
 5. Adjustable slide rail motor mounts.
 6. Adjustable screw type LVP or VP for over one groove on motors less than 50 hp.
 7. Motors 50 hp and larger may be furnished with two nonadjustable motor pulleys, one for testing and for final operation.

PART 3 – EXECUTION

3.01 EFFICIENCY

- A. The manufacturer shall provide a certified test report stating that horizontal motors provided were tested by IEEE Standard 112, Method B, and found to have efficiencies guaranteed to equal or exceed the values shown in the tables below:

Horsepower	Guaranteed Minimum Efficiency
1	78.5%
1-1/2	81.5%

2	81.5%
3	84.0%
5	85.0%
7-1/2	88.0%
10	90.0%
15	90.0%
20	90.5%
25	91.0%
30	91.5%
40	93.0%
50	93.0%
60	93.0%
75	93.0%
100	94.0%
125	94.0%
150	94.0%
200	94.5%

3.02 INSTALLATION

- A. Install to conform to manufacturer's instructions.
- B. Lubricate all bearings, gears and items requiring lubrication before placing them in operation.

END OF SECTION

SECTION 16170 – CIRCUIT AND MOTOR DISCONNECTS

PART 1 – GENERAL

1.01 SUMMARY

- A. Extent of circuit and motor disconnect switch work is indicated on drawings and schedules.
- B. Types of circuit and motor disconnect switches in this section include the following:
 - 1. Equipment disconnects
 - 2. Motor circuit disconnects
- C. Refer to other Division – 16 section for wires/cables, raceways, and electrical boxes and fittings work required in connection with circuit and motor disconnect work; not work of this section.

1.02 DEFINITIONS

- A. This section is a Division – 16 Basic Electrical Materials and Methods section and is part of each Division 16 section and other divisions referring to circuit and motor disconnects.

1.03 SUBMITTALS

- A. Submit manufacturer's data on circuit and motor disconnect switches indicating number of poles, hp Ratings, Current Rating, Voltage Rating and NEMA Class of Enclosure.

1.04 QUALITY ASSURANCE

- A. National Electrical Code (NEC): Comply with NEC requirements pertaining to construction and installation of electrical circuit and motor disconnect device.
- B. Underwriters Laboratories, Inc.: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches". Provide circuit and motor disconnect switches which have been UL-listed and labeled.
- C. National Electric Manufacturers Associations: Comply with applicable requirements of NEMA Stds Pub No. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)".

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide circuit and motor disconnects of one of the following manufacturers (for each type of switch):
 - 1. Cutler Hammer.
 - 2. General Electric Co.
 - 3. Square D Co.
 - 4. Or approved equal.

2.02 DISCONNECT SWITCHES

- A. Single Phase Disconnect Switches: Provide surface-mounted, heavy-duty type, sheet-steel enclosed switches, of types, sizes, and electrical characteristics indicated; incorporating spring assisted, quick-make, quick-break switches which are so constructed that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating

position is easily recognizable and is capable of being padlocked in OFF position. Construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and stamped enclosure knockouts. Provide NEMA Type 1 enclosures in all interior locations and NEMA Type 4X enclosures in all exterior locations, unless noted otherwise on drawings.

- B. Three Phase Disconnect Switches: Provide surface-mounted, heavy-duty type, sheet-steel enclosed switches, of types, sizes, and electrical characteristics indicated; incorporating spring assisted, quick-make, quick-break switches; construct so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable and is padlockable in OFF position; construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and positive pressure type reinforced fuse clips. Provide NEMA Type 1 enclosures in all interior locations and NEMA Type 4X enclosures in all exterior locations, unless noted otherwise on drawings.

PART 3 – EXECUTION

3.01 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.

3.02 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for electrical disconnect switches where indicated.

3.03 FIELD QUALITY CONTROL

- A. Subsequent to completion of installation of electrical disconnect switches, energize circuitry, and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

END OF SECTION

SECTION 16264 – STANDBY DIESEL GENERATOR

PART 1 – GENERAL

1.01 REFERENCES AND STANDARDS

- A. The generator set covered by these specifications shall be designed, tested, rated, assembled, and installed in strict accordance with all applicable standards below:
 - 1. UL508
 - 2. UL2200
 - 3. UL142
 - 4. NEMA MG1
 - 5. Designed to allow for installed compliance to NFPA 37, NFPA 70, NFPA 99 and NFPA 110
 - 6. ISO 8528

1.02 WORK INCLUDED

- A. Installation:
 - 1. The work includes supplying and installing a complete integrated generator system. The system consists of a diesel generator set with related component accessories and automatic transfer switches specified under a separate section.
- B. Fuel System:
 - 1. The CONTRACTOR shall provide a full tank of diesel fuel after the completion of all testing and start-up.
- C. System Test:
 - 1. A complete system load test shall be performed after all equipment is installed. Guidelines in the Start-up Section.
- D. Requirements, Codes and Regulations:
 - 1. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a MANUFACTURER who has 25 years of experience building this type of equipment. The manufacturer shall be ISO9001 certified.

1.03 SUBSTITUTION

- A. Generator manufacturers are to be selected from the following:
 - 1. Aksa Power Generation
 - 2. Cat Standby Generators
 - 3. Cummins Power Generation
 - 4. Generac
 - 5. Gillette
 - 6. HiPower Systems
 - 7. Kohler
 - 8. mtu / Rolls Royce
 - 9. Taylor Power Systems
 - 10. Winco Generators

- B. Proposed deviations from the specifications shall be treated as follows:
 - 1. Requests for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be addenda only.

1.04 SUBMITTALS

- A. Engine-generator submittals shall include the following information:
 - 1. Factory published specification sheet.
 - 2. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc.
 - 3. Dimensional elevation and layout drawings of the generator set enclosure and transfer switchgear and related accessories.
 - 4. Weights of all equipment.
 - 5. Concrete pad recommendation, layout, and stub-up locations of electrical and fuel systems.
- B. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, control panel, and remote alarm indications.
- C. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.
- D. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
- E. Generator resistances, reactances, and time constants.
- F. Generator locked rotor motor starting curves.
- G. Manufacturer's documentation showing maximum expected transient voltage and frequency dips, and recovery time during operation of the generator set at the specified site conditions with the specified loads.
- H. Manufacturer's and dealer's written warranty and extended service coverage.
- I. Pre Commissioning Inspection Form provided by the generator supplier to be completed by Contractor upon installation, detailing items to be verified and responsibilities of the Contractor prior to generator supplier commissioning.

1.05 SYSTEM RESPONSIBILITY

- A. Generator Set Distributor:
 - 1. The completed engine generator set shall be supplied by the Manufacturer's authorized distributor only.
- B. Requirements, Codes and Regulations:
 - 1. The equipment supplied and installed shall meet the requirements of NEC and all-applicable local codes and regulations. All equipment shall be new, of current production. There shall be one source responsibility for warranty parts and service through a local representative with factory trained service personnel.

- C. Automatic Transfer Switch:
 - 1. The automatic transfer switch(es) specified in another section shall be supplied by the generator set manufacturer to establish and maintain a single source of system responsibility and coordination.

1.06 WARRANTY

- A. Two Year Standby (ISO 8528-1: ESP) Generator Set Warranty:
 - 1. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.
 - a. Parts and service qualifications
- B. Service Facility:
 - 1. The engine-generator supplier shall maintain 24-hour parts and service capability within 100 miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.
- C. Service Personnel:
 - 1. The dealer shall maintain qualified factory trained service personnel. Service contracts shall also be available.

PART 2 – PRODUCTS SPECIFICATIONS

2.01 GENERAL REQUIREMENTS

- A. Genset Requirements:
 - 1. The generator set shall be Standby Duty rated at:
 - a. 90 kW, minimum.
 - 2. Voltage:
 - a. 480/277 V, 3-Phase
 - 3. 60 hertz, including radiator fan and all parasitic loads. Generator set shall be sized to operate at the specified load at a maximum ambient of 104F (40 C) and altitude of 1,200.0 feet (365.7 m).
 - 4. Power is available for the duration of an emergency outage.
 - 5. Average Power Output = 70% of standby power
 - 6. Load = Varying
 - 7. Typical Hours/Year = 200 Hours
 - 8. Maximum Expected Usage = 500 hours/year
 - 9. Typical Application = Standby
- B. Material and Parts:
 - 1. All materials and parts comprising the unit shall be new and unused.
- C. Engine:
 - 1. The engine shall be diesel fueled, four (4) cycle, water-cooled, while operating with nominal speed not exceeding 1800 RPM. The engine will utilize in-cylinder combustion technology, as required,

to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Additionally, the engine shall comply with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified kW / bHP rating. Emissions requirements / certifications of this package:

a. EPA T3

D. Engine Governing:

1. The engine will be equipped with an isochronous electronic governor to maintain +/- 6 RPM steady state frequency variation from steady state no load to steady state full load.
2. The engine will be equipped with an isochronous electronic governor to maintain +/-0.7% steady state frequency variation from steady state no load to steady state full load.

2.02 GENERATOR

A. Generator Specifications:

1. The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G2 of ISO 8528. The excitation system shall be of brushless construction.

B. Integrated Voltage Regulator (IVR):

1. The IVR shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage or operating in single phase sensing mode. The IVR shall be cable of configuring knee frequency and voltage regulation configurable up to +/-30%. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic to optimize voltage and frequency response for site conditions. The IVR shall be capable of setpoint adjustment.

2.03 CIRCUIT BREAKER

A. Circuit Breaker Specifications:

1. Provide a generator mounted circuit breaker, molded case, Qty. (1) 200 amp trip, NEMA 1/IP22. Breaker shall utilize a solid-state trip unit. The breaker shall be UL/CSA Listed and connected to engine/generator safety shutdowns. The breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown in the drawing, shall be supplied on the load side of breaker.

2.04 CONTROLS – GENERATOR SET MOUNTED (EMCP 4.2)

A. Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real-time digital communications to all engine and regulator controls via SAE J1939.

B. Environmental:

1. The generator set control shall be tested and certified to the following environmental conditions:
 - a. -40°C to +70°C Operating Range
 - b. 100% condensing humidity, 30°C to 60°C
 - c. IP22 protection for rear of controller; IP55 when installed in control panel.
 - d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
 - e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz

- f. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)
- g. Shock: withstand 15G

C. Functional Requirements:

- 1. The following functionality shall be integral to the control panel:
 - a. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transfective LCD display with text-based alarm/event descriptions.
 - b. The control shall include a minimum of 3-line data display.
 - c. Audible horn for alarm and shutdown with horn silence switch.
 - d. Standard ISO labeling
 - e. Multiple language capability
 - f. Remote start/stop control.
 - g. Local run/off/auto control integral to system microprocessor.
 - h. Cooldown timer
 - i. Speed adjust
 - j. Lamp test
 - k. Emergency stop push button
 - l. Voltage adjust
 - m. Voltage regulator V/Hz slope adjustment
 - n. Password protection system programming

D. Digital Monitoring Capability:

- 1. The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units. In addition to any communication requirements listed, the generator controller shall make the signals available as shown in the drawings:
 - a. Engine:
 - i. Engine oil pressure
 - ii. Engine oil temperature
 - iii. Engine coolant temperature
 - iv. Engine RPM
 - v. Battery volts
 - vi. Engine hours
 - vii. Engine crank attempt counter
 - viii. Engine successful start counter
 - b. Generator:
 - i. Generator AC volts (Line to Line, Line to Neutral and Average)
 - ii. Generator AC current (Avg and Per Phase)
 - iii. Generator AC Frequency
 - iv. Generator kW (Total and Per Phase)
 - v. Generator kVA (Total and Per Phase)
 - vi. Generator kVAR (Total and Per Phase)
 - vii. Power Factor (Avg and Per Phase)
 - viii. Total kW-hr
 - ix. Total kVAR-hr
 - x. % kW
 - xi. % kVA
 - xii. % kVAR
- 2. Voltage Regulation:
 - a. Excitation voltage
 - b. Excitation current
- 3. Alarms and Shutdowns:

- a. The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence.
- 4. Engine Alarm/Shutdown:
 - a. Low oil pressure alarm/shutdown
 - b. High coolant temperature alarm/shutdown
 - c. Loss of coolant shutdown
 - d. Overspeed shutdown
 - e. Overcrank shutdown
 - f. Emergency stop shutdown
 - g. Low coolant temperature alarm
 - h. Low battery voltage alarm
 - i. High battery voltage alarm
 - j. Control switch not in auto position alarm
 - k. Battery charger failure alarm
- 5. Generator Alarm/Shutdown:
 - a. Generator phase sequence
 - b. Generator over voltage
 - c. Generator under voltage
 - d. Generator over frequency
 - e. Generator under frequency
 - f. Generator reverse power (real and reactive)
 - g. Generator overcurrent
- 6. Voltage Regulator Alarm/Shutdown:
 - a. Loss of excitation alarm/shutdown
 - b. Instantaneous over excitation alarm/shutdown
 - c. Time over excitation alarm/shutdown
 - d. Rotating diode failure
 - e. Loss of sensing
 - f. Loss of PMG
- E. Inputs and Outputs:
 - 1. Programmable Digital Inputs:
 - a. The Controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.
- F. Programmable Relay Outputs:
 - 1. The control shall include the ability to operate programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6) Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally Closed) contacts.
 - 2. One Programmable Relay Outlet shall be capable of generating a signal for general alarm to owner's controls.

2.05 COOLING SYSTEM

- A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110 F ambient air entering the room or enclosure (If an enclosure is specified). The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

2.06 FUEL SYSTEM

- A. Fuel System:
 - 1. The fuel system shall be integral with the engine. In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted. Flexible fuel lines shall be rated minimally for 300 degrees F and 100 psi.
- B. Fuel Sub-base Tank:
 - 1. Provide a double wall sub-base tank constructed to meet all local codes and requirements. A fuel tank base of 24 hour capacity shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall meet UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided.

2.07 STARTING SYSTEM

- A. Starting Motor:
 - 1. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
- B. Coolant Heater:
 - 1. A jacket water heater shall be provided and shall be sized to ensure that genset will start within the specified time period and ambient conditions.
- C. Batteries:
 - 1. A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system.
- D. Battery Charger:
 - 1. A UL listed/CSA certified voltage regulated battery charger shall be provided for each engine-generator set. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float and equalize charge settings, with provisions to automatically switch between the two modes. It shall maintain its rated output voltage within $\pm 0.2\%$ with AC input variation of $\pm 10\%$. Operational monitors shall provide individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of battery charger malfunction, low battery voltage, and high battery voltage. The charger shall include an Analog DC voltmeter and ammeter and fused AC input and DC output and shall be wall mount type in a NEMA 1 enclosure.
- E. Customer Supplied AC Power:
 - 1. Battery charger and coolant heater circuits shall be separately powered from separate, Owner-supplied, circuit breakers to allow continued operation of the battery charger in the instance of a coolant heater system failure that causes the coolant heater circuit breaker to trip.

2.08 ENCLOSURE

- A. Sound Attenuated Enclosure:
 - 1. The complete engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure including the following:
 - a. A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. Enclosures shall have a resulting sound level as follows:
 - i. 71 dba @ 23ft with the genset running under full load.
 - b. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

- c. Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.
- d. Lube oil and coolant drains shall be extended to the side rail of the base frame and include drain valves. Cooling fan and charging alternator shall be fully guarded to prevent injury.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes.

3.02 START-UP AND TESTING

- A. Generator supplier start up and commissioning testing shall be included in the scope of the generator and ATS purchase agreement. Coordinate all start-up, testing, and commissioning activities with the Engineer, Owner, and generator supplier.

3.03 OPERATION AND MAINTENANCE MANUAL

- A. Provide two (2) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

3.04 TRAINING

- A. On-Site Training:
 - 1. Provide on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures.

END OF SECTION

SECTION 16414 – AUTOMATIC TRANSFER SWITCH

PART 1 – GENERAL

1.01 SCOPE

- A. It is the intent of this specification to secure a transfer switch that has been prototype tested, factory built, production tested, and site tested. A transfer switch with the number of poles, voltage and current ratings as shown:

Size	Voltage	Poles	Enclosure
400 amps	480/277	3	NEMA 3R

1.02 CODES AND STANDARDS

- A. The automatic transfer switch shall conform to the requirements of:
1. UL 1008: Underwriters Laboratories standard for automatic transfer switches
 2. CSA: C22.2 No. 178 certified at 600 VAC
 3. IEC: 947-6-1 certified at 480V AC
 4. NFPA 70: National Electrical Code including use in emergency and standby systems in accordance with Articles 517, 700, 701, 702
 5. NFPA 99: Essential electrical systems for health care facilities
 6. NFPA 101: Life Safety Code
 7. NFPA 110: Standard for emergency and standby power systems
 8. IEEE 241: IEEE Recommended Practice for Electric Power Systems in Commercial Buildings
 9. IEEE 446: IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
 10. NEMA ICS10 Part 1: Industrial Control and Systems Part 1: Transfer Switch Equipment
 11. UL 50/508: Enclosures for Electrical Equipment, Non-Environmental Considerations
 12. ICS 6: Industrial Control and Systems: Enclosures
 13. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

1.03 APPROVED MANUFACTURERS

- A. Automatic transfer switch manufacturers are to be selected from the following:
1. ASCO
 2. Cummins
 3. Eaton
 4. Generac
 5. Honeywell
 6. Kohler
 7. Schneider Electric
- B. Alternate manufacturers shall submit a request a minimum of ten (10) days prior to bid and include a written list of deviations from this specification to be considered for approval.

PART 2 – PRODUCTS

2.01 PERFORMANCE AND CONSTRUCTION

- A. The automatic transfer switch shall be of double throw construction operated by a reliable solenoid driven mechanism. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.
- B. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.
- C. For switches installed in systems having ground fault protective devices, and/or wired to be designated a separately derived system by the NEC, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability will not be considered.
- D. The contact structure shall consist of a main current carrying contact, which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes above 600 Amps.
- E. The transfer switch manufacturer shall submit test data for each size switch, showing it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Minimum UL listed withstand and close into fault ratings shall be as follows:

<u>Size (Amps)</u>	<u>Coordinated Breaker</u>	<u>Current Limiting Fuse</u>
40 - 225	30,000	200,000
260 to 600	50,000	200,000

(all values at 480V RMS symmetrical, less than 20% power factor)

- F. A dielectric test at the conclusion of the withstand and closing tests shall be performed.
- G. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation between a normal and emergency source that are 120 degrees out of phase at 480 volts, 600% of rated current at .50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.
- H. All relays shall be continuous duty industrial type with wiping contacts. Coils, relays, timers, and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.
- I. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.
- J. A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection, or manual operation.
- K. Switches composed of molded case breakers, lighting contactors or components thereof will not be acceptable.
- L. The current rating shall be a continuous rating when the switch is installed in an enclosure and shall conform to NEMA temperature rise standards.

- M. The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast, and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.
- N. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.
- O. Unless specified otherwise on the drawings, the switch shall be mounted in a NEMA 3R enclosure.

2.02 CONTROL

- A. The control panel shall be opto-isolated from electrical noise and provided with the following inherent control functions and capabilities:
 - 1. Easy-to-view 4 x 20 LCD display with long lasting LED indicators.
 - 2. Control panel shall display voltage and frequency of both sources.
 - 3. The user shall be able to view the last 16 recorded events.
 - 4. Capability for external communication and network interface.
 - 5. Adjustments to all settings shall be made from the front of the panel without opening the door.
- B. The transfer switch shall be equipped with a microprocessor-based control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position, source availability, sequence indication and diagnostics.
- C. All programmable and control functions shall be passcode protected and accessible through the keypad.
- D. The control panel shall be provided with a simple user interface for transfer switch monitoring, control and field changeable functions and settings.
- E. Touch pad test switch with Fast Test/Load/No Load selection capability to simulate a normal source failure.
- F. The controller shall provide digital timer adjustments with 1-second resolution. Voltage and Frequency shall be adjustable to 1% resolution to facilitate accurate transfer.
- G. To ensure reliable and consistent user operation the controls must be equipped with nonvolatile memory and allow automatic daylight savings time adjustment.
- H. In addition to any communication requirements listed, the generator controller shall make the signals available as shown on the drawings.

PART 3 – OPERATION

3.01 SEQUENCE OF OPERATION

- A. The ATS shall incorporate adjustable three phase under voltage sensing on the normal source (or single phase, as appropriate for a single phase ATS).
- B. When the voltage of any phase of the normal source is reduced to 80% (adjustable) of nominal voltage, for a period of 0-10 seconds (programmable), a pilot contact shall close to initiate starting of the engine generator.

- C. The ATS shall incorporate adjustable under voltage and under frequency sensing on the emergency source.
- D. When the emergency source has reached a voltage value of 90% of nominal and achieved frequency within 95% of the rated value, the load shall be transferred to the emergency source after a programmable time delay.
- E. When the normal source has been restored to not less than 90% of rated voltage on all phases, the load shall be retransferred to the normal source after a time delay of 0 to 60 minutes (programmable). The generator shall run unloaded for 5 minutes (programmable) and then automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.
- F. If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90%) on the normal source.
- G. Inspection and operational testing/demonstration of the ATS shall be conducted in the presence of the owner's representative to indicate the ATS satisfies these specifications.

3.02 ATS FEATURES

- A. In addition to the operational elements required to satisfy the sequence of operation and other functions specified herein, the following ATS features shall be provided:
 - 1. Adjustable time delay to override momentary normal source failure prior to engine start. Field programmable 0-10 seconds factory set at 3 seconds.
 - 2. Adjustable time delay on retransfer to normal source, programmable 0-60 minutes factory set at 30 minutes. If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.
 - 3. A time delay on transfer to emergency, programmable 0-5 minutes, factory set at 1 second.
 - 4. An in-phase monitor shall be provided. The monitor shall compare the phase angle difference between the normal and emergency sources and be programmed to anticipate the zero crossing point to minimize switching transients.
 - 5. An exerciser timer with momentary test pushbutton shall be incorporated within the microprocessor and shall be capable of starting the engine generator set and transferring the load (when selected) for exercise purposes on a daily, weekly, or monthly basis. The exerciser shall contain a battery for memory retention during an outage.
 - 6. Provide a momentary pushbutton to bypass the time delays on transfer and retransfer and programmable commit/no commit control logic.
 - 7. The controller shall accept a remote peak shave or test input to signal the transfer switch to the emergency position.
 - 8. A set of customer contacts shall be provided to indicate both emergency and normal source position.
 - 9. The following optional Exerciser Package shall be included:
 - a. Additional Auxiliary Contact - Closed when the transfer switch is in Source 2 position.
 - b. Additional Auxiliary Contact - Closed when the transfer switch is in Source 1 position.
 - c. Additional Auxiliary Contact - Closed when the transfer switch is in Source 1 position.
 - d. Voltage Imbalance Monitor - Three Phase sensing shall detect an imbalance and initiate a transfer to the alternate source. Adjustable 5-20% of nominal with a time delay of 10-30 seconds for nuisance conditions.

PART 4 – EXECUTION

4.01 GENERAL

- A. The transfer switch shall be installed as shown on the plans, in accordance with the manufacture's recommendations and all applicable codes.

4.02 FACTORY TESTS

- A. The transfer switch manufacturer shall perform a complete functional test on the switch, controller, and accessories prior to shipping from the factory. A certified test report shall be available upon request.

4.03 SERVICE

- A. The supplier of the ATS shall be the same as that of the engine generator set and shall maintain a national service organization that is factory trained and certified for transfer switch equipment. In addition, the genset dealer organization shall be available 24 hours per day, 365 days per year.

4.04 WARRANTY

- A. The automatic transfer switch shall be warranted against defective workmanship for a period of two years, including both parts and labor.

END OF SECTION

SECTION 16450 – GROUNDING

PART 1 – GENERAL

1.01 SUMMARY

- A. Extent of grounding work is indicated by drawings and schedules.
- B. Types of grounding specified in this section include the following:
 - 1. Solid grounding.
- C. Applications of grounding work in this section include the following:
 - 1. Underground metal piping
 - 2. Underground metal structures
 - 3. Grounding electrodes
 - 4. Grounding rods
 - 5. Service equipment
 - 6. Enclosures
 - 7. Equipment

1.02 RELATED SECTIONS

- A. This section is a Division 16 Basic Materials and Methods section and is part of each Division 16 section and other divisions referring to grounding specified herein.
- B. Submit compliance submittals including layout drawings of grounding systems and accessories including, but not limited to, ground wiring, copper braid and bus, ground rods, and plate electrodes.
- C. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.
- D. American Society of Testing Materials (ASTM): Comply with applicable requirements of B8 for copper conductors.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide grounding products of one of the following manufacturers:
 - 1. B-Line Systems Inc.
 - 2. Burndy Corp.
 - 3. Crouse-Hinds Co.
 - 4. Electrical Components Div; Gould Inc.
 - 5. General Electric Supply Co.
 - 6. Ideal Industries, Inc.
 - 7. Thomas and Betts Corp.
 - 8. Or approved equal.

2.02 GROUNDING SYSTEMS

- A. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs),

grounding rods/electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type of unit meets indicated requirements, selection is the Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

- B. Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC:
 - 1. Solid in sizes 4 AWG and smaller.
 - 2. ASTM Class B stranded in sizes 2 AWG and larger.
- C. Grounding Rods: Steel with copper welded exterior, 5/8" dia. x 8'.
- D. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service indicated.
- E. Field Welding: Comply with manufacturer's recommendations for exothermic procedures, appearance, and quality of welds; and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground wire, grounding rods/electrodes.

PART 3 – EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work. Protect cable against damage during construction. Replace or repair in approved manner any cable damaged before final acceptance.
- C. Exposed Installations:
 - 1. Route as indicated to achieve maximum physical protection.
 - 2. Support at intervals of 3' or less with nonmagnetic clamp-type supports.
- D. Ground Rods:
 - 1. Install rods as indicated by driving and not by drilling or jetting.
 - 2. Drive rods into unexcavated portions of the earth where possible.
 - 3. Where rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
 - 4. Drive to a depth such that top of rods will be approximately 18" below final grade or subgrade and connect main grid ground cable thereto.
- E. Connections:
 - 1. Conform to manufacturer's instructions.
 - 2. Chemically degrease and dry completely before welding.
 - 3. Apply one coat of coal tar coating at 15 mils dry film thickness to all exothermic-welded connections to be buried.
 - 4. Make connections to equipment clean and tight to assure a low-resistance connection with resistance not exceeding 1 ohm. Install so as not to be susceptible to mechanical damage during operation or maintenance of equipment.

- F. Metallic Conduit Grounds:
 - 1. Adequately and properly ground at all terminal points and wherever isolated from equipment or grounded steel.
 - 2. Where extending into equipment, connect to equipment ground bus or frame.
- G. Box Grounds: Unless grounded by conduit system, ground all boxes by direct copper connection to the buried ground grid system.
- H. Ground all motors with “identified” ground conductor in addition to conduit system. Route in conduit with phase conductors unless external ground is indicated.

3.02 FIELD QUALITY CONTROL

- A. Provide field testing as specified in this section.

END OF SECTION

SECTION 16482 – MOTOR STARTERS AND RELATED ACCESSORIES

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. This section includes starters, contactors, relays, switches, and circuit breakers.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, Specification sections, apply to work of this section.
- B. This section a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section and other divisions referring to motor starters specified herein.

1.03 SUBMITTALS

- A. Submit in accordance with Division 1.
- B. Submit manufacturer's product data on motor starters.
- C. Submit wiring diagrams for motor starters showing connections to electrical motors and control devices.

1.04 QUALITY ASSURANCE

- A. National Electrical Code (NEC): Comply with NEC as applicable to wiring methods construction and installation of motor starters.
- B. National Fire Protection Association (NFPA): Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
- C. Underwriters Laboratories, Inc (UL): Comply with applicable requirements of UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL 508, "Electrical Industrial Control Equipment" pertaining to installation of motor starters. Provide motor starters and components which are UL-listed and labeled.
- D. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements of IEEE Std 241, "Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to motor starters.
- E. National Electrical Manufacturers Association (NEMA): Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," pertaining to motor controllers/starters and enclosures.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide motor starters and accessories of one of the following (for each type and rating of motor starter):

1. Cutler Hammer Inc.
2. Siemens Inc.
3. General Electric Co.
4. Square D Company.
5. Or approved equal.

2.02 GENERAL

- A. Except as otherwise indicated, provide NEMA motor starters and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information, and as required for complete installation. Motor starters utilizing IEC tested components will not be acceptable.
- B. Provide NEMA enclosure construction suitable for service and location.
- C. Provide engraved nameplate on cover of each unit with wording as approved by the Engineer.

2.03 FRACTIONAL HORSEPOWER MANUAL STARTERS

- A. Cutler-Hammer Type MS for 120 volt motors.
- B. Overload heaters to match motor nameplate data.
- C. Pilot lights where indicated.

2.04 MAGNETIC STARTERS

- A. Full Voltage Type Motor Starters:
 1. AC combination, nonreversing or reversing with disconnect switch or breaker as specified or indicated.
 2. Solid state overload protection relay in 3-phase units to match motor nameplate data. Relay shall have built-in phase loss/reversal and undervoltage protection.
 3. Built-in 480/120 volt control transformer on 480 volt units of adequate capacity for all control devices as indicated.
 4. Necessary auxiliary contacts as required by means of starter or relay.
 5. Operating handle for disconnect switch mechanism interlocked with enclosure door.
 6. Be capable of being locked in OFF position with three padlocks.
- B. Reduced Voltage Type Motor Starters:
 1. Solid state type reduced voltage motor starters with circuit-breaker type disconnects and auxiliary control devices as indicated. Motor starters shall have built-in programmable overload protection having the following protective features:
 - a. Overtemperature
 - b. Jam
 - c. Stall
 - d. Phase loss.
 - e. Phase reversal
 - f. Shorted SCR detection
 2. Motor starters shall have adjustable ramp start to provide constant increase in torque and current limiting start to limit the maximum current available to the motor during start-up. Motor starters shall also have built-in run bypass contact.
 3. Provide not less than 2 normally-open and 2-normally-closed spare auxiliary contacts wired to terminal blocks. The circuit protective device and starter combination shall have an interrupting rating of not less than 65,000 amperes RMS symmetrical.

4. Each motor starter unit shall be housed in a NEMA 1 enclosure supplied with a thermostatically controlled strip heater to allow proper starter operation at ambient temperatures of -20 degrees F (-29 degrees C).
5. Motor starters shall be IEC 947 compliant and shall be UL listed. Motor starters shall be equal to model IT (Intelligent Technologies) solid state motor starters as manufactured by Cutler-Hammer.

2.05 PUSHBUTTONS AND SELECTOR SWITCHES

- A. Heavy-duty oiltight type.
- B. NEMA type 1 enclosure for indoor service.
- C. NEMA Type 3R enclosure for outdoor service.

2.06 AUXILIARY RELAYS

- A. Coils rated 120 or 240 volts, AC.
- B. Contacts rated 10 A up to 300 V.
- C. NEMA Type 1 enclosure for indoor service and NEMA Type 3R for outdoor service when separately mounted.
- D. Contacts as required for control of associated equipment.
- E. Industrial type 300 V relays.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install motor starters, combination starters, contactors, relays, switches and circuit breakers as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL and NEMA standards, to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation with other work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.
- D. Mount motor starters and combination motor starters approximately 4 feet to centerline above the floor, where possible.
- E. Provide proper grounding.

3.02 FIELD QUALITY CONTROL

- A. Field test as specified in this Division.
- B. Touch up scratched or marred surfaces to match original surface.

END OF SECTION

SECTION 17010 – INSTRUMENTATION SYSTEM COORDINATION

PART 1 – GENERAL

1.01 SUMMARY

- A. This Division includes performance requirements and system coordination as specified herein and in each Section.

1.02 SUBMITTALS

- A. The manufacturer with system coordination responsibility shall assume responsibility for all compliance submittals.
- B. Includes, but not limited to, the following:
 - 1. Electrical and mechanical connection diagrams for all separately mounted instruments.
 - 2. Individual specification or descriptive sheets for instruments, annunciators and similar major system components to conform to ISA S20.
 - 3. Instruction Books: For all instruments, annunciators, transducers, and similar major system equipment.

1.03 QUALITY ASSURANCE

- A. Instrument Society of America (ISA):
 - 1. S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
- B. Joint Industry Council Standards (JIC):
 - 1. EMP-1-67-Mass Production Equipment.

PART 2 – PRODUCTS

2.01 AS SPECIFIED IN APPLICABLE SECTIONS

PART 3 – EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

- A. As specified in Division 1
- B. Provide serviceman for a minimum of 1 working day, with days more than this as required during the test and start-up period.
- C. Test and start-up supervision to continue until the system is in proper operating condition as determined by the Engineer.
- D. Provide manufacturer's supervision during installation and start-up to correct deficiencies in equipment manufactured by them and to correct deficiencies in the installation and wiring of equipment at no increase in the contract price.
- E. Required for all instruments, control devices, and other devices furnished as a part of the instruments and associated control devices separately mounted to assure proper installation, setting, connection, and functioning.

- F. The prime responsibility manufacturer shall be responsible for trouble-shooting the systems to determine the cause for not functioning correctly. This is to include equipment furnished by the manufacturer as well as all systems which supply inputs or receive outputs from this division. The manufacturer shall correct all problems with their equipment and notify the Engineer through General Contractor of all other suppliers' deficient components.

END OF SECTION

SECTION 17200 – CONTROL PANELS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. This Division includes control panels as specified in this and other Sections. Owner will provide Control Panels and Contractor must install Control Panels as specified herein and coordinate with the District Systems Integrator for PLC programming and SCADA communications.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is a Division 17 Basic Materials and Methods section and is part of each Division 17 section and other divisions referring to control panels specified herein.

1.03 QUALITY ASSURANCE

- 1. National Electrical Code (NEC). Comply with NEC requirements as applicable to electrical installations including, but not limited to, conduit, conductors and grounding.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Panels are to be secured to foundation(s) or electrical equipment rack using stainless steel hardware by way of panel manufacturer provisions. Concrete anchors are to be post-install and use all provided panel manufacturer mounting holes.
- B. All wiring as indicated on the control panel manufacturer's documentation and as indicated on project drawings are to be included in the Contractor's Scope.
- C. All PLC programming and SCADA communications will be provided by the District's System Integrator.
- D. Motor drives are to be programmed during startup as recommended by the pump supplier. Programming features such as max/min amperage; max/min voltage; automatic restart on fault; and number of starts per hour.
- E. Electrical service and all items necessary to make a complete operational pump station are required.
- F. All conductors shall be identified with slip-on, hot-stamped spaghetti or sleeve type with computer printed numbers. Acceptable manufacturers for the hot-stamped spaghetti type are Brady Ty-grip, Brady BT or DAT, Electrovert type Z, or approved equal. Acceptable manufacturers for the sleeve type are Brady, T&B or approved equal. Both ends of conductor shall be identified with the same unique identifier.
- G. Conductors entering the control panel enclosure are to be routed in the control panel as to not interfere with operation or accessibility to control panel components. The Owner or Engineer is to be contacted in the instance of conflict of conductors with control panel components.

- H. Instrument DC signal wiring shall be routed in separate ducts or groups from AC power and control wiring.
- I. All external conductors must be terminated at terminal blocks or control panel devices provided by and installed in the panel by the panel fabricator.
- J. Bottom entry of conduit into the control panel is preferred except as otherwise noted.
- K. Canopy fabrication and installation is the responsibility of the control panel supplier.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Conform to requirements as specified in General Conditions and Division 1.
- B. Conduct all tests in the presence (if so requested) of Engineer and Owner under the supervision of equipment manufacturer's field engineer.
- C. Notify Engineer two weeks prior to the commencement of all tests.
- D. Include all tests recommended by the equipment manufacturer unless specifically waived by the Engineer.
- E. Include all additional tests recommended by the Engineer that he deems necessary because of field conditions, to determine that equipment and material and systems meet the requirements of Contract Documents.
- F. Be responsible for all damage to equipment and material due to improper test procedures or test apparatus handling.

3.02 FUNCTIONAL TESTING OF CONTROLS

- A. Verification of control panel wiring before installation shall be done by the control panel manufacturer to standard industry practices consisting of point-to-point wiring checks and power-up tests.
- B. Include operating control system from each control point.
- C. Control panel supplier shall be responsible for verifying control panel operation based on field inputs and outputs to the control panel. Panel supplier will not be responsible for installation, setup, programming, repair or replacement of field devices interfacing with the control panel.
- D. The control panel supplier shall coordinate with the Owner to verify alarm points that are part of the control panel functionality and verify SCADA inputs and outputs function as the Owner intends. Silence and acknowledge of audiovisual alarms are to be verified.
- E. Operate by hand all relays, switches and other system components that cannot be operated in a normal manner with equipment not in service.
- F. Repeat with equipment in operation.

END OF SECTION

SECTION 17300 – INSTRUMENT REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Float Switches
- B. All similar types of instruments shall be of one manufacturer.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 Specification sections, apply to work of this section.
- B. Submit individual instrument specification and data sheets conforming to ISA S20.

1.03 SUBMITTALS

- A. Submit details, drawings and operation and maintenance manuals in accordance with Division 1
- B. Submit individual instrument specification and data sheets conforming to ISA S20.

1.04 QUALITY ASSURANCE

- A. Standards:
 - 1. American National Standards Institute (ANSI).
 - 2. National Electrical Manufacturers Association.
 - 3. Instrument Society of America.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Float Switches:
 - 1. Anchor Scientific, Inc.

2.02 GENERAL

- A. Provide mounting brackets and pipe stands as required to install all field-mounted instruments.
- B. Provide all accessories required for complete and working system.

2.03 FLOAT SWITCHES

- A. Rigid, high-density polyurethane tear-drop shape float.
- B. An internal independent mercury switch, NO or NC, as indicated, rated 10 amps at 250 volts ac noninductive.
- C. Furnished with necessary length of cable and weight kit for cable suspension.

- D. The ROTO-FLOAT, Type S, Anchor Scientific, Inc., with built-in weight.
- E. Power supplies shall be provided where not included in a controller.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Manufacturers Field Services: Provide as specified in Division 1 and this Division.
- B. Field Testing:
 - 1. General Requirements: Conduct all tests in the presence (if so requested) of Engineer under the supervision of the equipment manufacturer's field representative. Include all tests recommended by the equipment manufacturer. Notify Engineer two weeks prior to the commencement of all tests.

END OF SECTION

SECTION 17600 – FIELD TESTING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. This section covers field testing of all wire, cable and electrical equipment and machinery.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, Specification sections, apply to work of this section.
- B. This section is a Division 16 Basic Electrical Materials and Methods section and is part of each Division 16 section and other Divisions referring to field testing specified herein.

1.03 QUALITY ASSURANCE

- A. Applicable Standards:
 - 1. American National Standards Institute (ANSI): Comply with:
 - a. C37.20 -Switchgear Assemblies, including Metal-Enclosed Bus.
 - 2. Insulated Cable Engineers Association (ICEA):
 - a. S-19-81-Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.
 - b. S-66-524-Cross-Linked Thermosetting Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - c. S-68-516-Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - 3. National Electrical Code (NEC).
 - 4. National Electrical Manufacturers Association (NEMA).

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following manufacturers:
 - 1. Ground Test Set:
 - a. Associated Research, Inc.
 - b. James G. Biddle Company.
 - c. Or approved equal.
 - 2. Multimeter:
 - a. Simpson Electric Co.
 - b. Or approved equal.
 - 3. Insulation Test Set:
 - a. Associated Research, Inc.
 - b. James G. Biddle Company.
 - c. Or approved equal.
- B. Test Reports:
 - 1. Submit as specified in Division 1.
 - 2. Maintain in duplicate a written record of all tests showing date, personnel making test, equipment used, equipment or material testing, tests performed, and results.
 - 3. Notify Engineer two weeks prior to commencement of all testing except for megger tests.

2.02 EQUIPMENT

- A. Provide all testing equipment required which includes all or some of the following:
 - 1. Wet- and dry-bulb thermometer.
 - 2. 500V and 1,000V meggers.
 - 3. Battery-powered portable telephone sets and portable radios.
 - 4. DC high-potential test set, adjustable up to 90 kV.
 - 5. One Multimeter (Volts-Ohms-Amperes) rated 20 K ohms per volt or better.
 - 6. One-phase rotation meter, 60 Hz.
 - 7. Commercial model three-point ground test set, James G. Biddle Company "Megger" Ground Tester or Associated Research, Inc., "Vibroground" tester.
 - 8. Miscellaneous cable, test lights, buzzers, bells, switches, receptacles, plugs, and other equipment as required.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Test all wire, cable, and electrical equipment installed or connected by Contractor to assure proper installation, setting, connection, and functioning as indicated or to conform to Contract Documents and manufacturer's instructions.
- B. Conduct all tests except megger insulation testing in the presence of Engineer or Owner and under the supervision of equipment manufacturer's field engineer.
- C. All testing involving control(ed) equipment shall be coordinated with the District's Systems Integrator.
- D. Include all tests recommended by the equipment manufacturer unless specifically waived by Engineer.
- E. Include all additional tests issued by the Engineer that he deems necessary because of field conditions, to determine that equipment and material and systems meet the requirements of Contract Documents.
- F. Be responsible for all damage to equipment or material due to improper test procedures or test apparatus handling.

3.02 PERFORMANCE TESTING

- A. 600V Insulated Case Breaker Test:
 - 1. Check ground connection.
 - 2. Visually inspect each breaker and operate manually.
 - 3. Check adjustable magnetic trips against values furnished by Engineer.
 - 4. Megger each pole for freedom from grounds.
 - 5. Check all connections.
 - 6. Check for proper current rating for circuit to which connected.
- B. 480 Volt Motor Control Center Tests:
 - 1. Check and measure resistance of equipment ground. Notify Engineer if more than 1 ohm.
 - 2. Clean all buses, insulators, etc. Open all breakers and test all buses for one minute with a high potential. Use following voltages:
 - a. 480 Volt Motor Control Centers: AC test value 1.65 kV. Either an AC or DC test voltage may be used, but AC is preferred.

3. Megger all control buses with a 1,000V megger, and report any grounds or short circuits to Engineer. Do not megger grounded AC circuits and do not megger instruments or fuses.
 4. Check all circuit breaker interlocks to conform to Contract Documents.
 5. Check all control circuits to conform to Contract Documents.
- C. Dry-Type Transformer Tests:
1. Check equipment ground to assure continuity of connections, as specified in this Division.
 2. Check the electrical neutral of the transformer. This connection shall be a copper wire connection to the ground bus, system grid, or conductor connected to the common grounding electrode, as indicated.
 3. Megger between high-voltage winding and low-voltage winding, high-voltage winding and ground, and low-voltage winding and ground. If readings are below 50 megohms (at 77 degrees F), notify Engineer before energizing transformer.
 4. Ratio test the full winding and all taps. Set transformer on tap as acceptable to Engineer.
 5. Check connections for tightness and clean out dust.
- D. Motor Tests on All Motors:
1. Check equipment ground to assure continuity of connections as specified in this Division.
 2. Measure the insulation resistance of the stator winding before applying voltage. Compare this measured value against the manufacturer's value. If there is no insulation resistance value furnished by manufacturer, use the following:

<u>Motor Voltage</u>	<u>Insulation Resistance</u>
600 volts and below	5 megaohms

- a. If measured resistance values are lower than above, record room temperature and humidity, and submit readings to Engineer before energizing. Dry out motors as required by accepted method of application of external heat and do not apply voltage to motor until substandard resistance condition is corrected. Megger readings are to be one-minute duration using a 500V megger for all motors 600V and below.
 3. Prior to final equipment alignment, disconnect motor from driven equipment where necessary to check lubrication, starter, and control circuits. If the motor is free of dirt and dust, rotate the rotor by hand to determine that motor turns freely. Clean out the motor if necessary. Apply voltage momentarily and note direction of rotation. Correct rotation if necessary. Reconnect motor to driven equipment.
 4. After being placed in operation, observe the motor for heating at the bearings or windings. If the motor appears to be running hot, notify the Engineer. Note: General purpose motors may operate at 176 degrees F (room temperature 104 degrees F).
 5. Take motor full-load amps readings (on all three legs of three-phase motors). Submit results to Engineer.
- E. Tests on Motor Starters, Contactors, and Industrial Relays:
1. Check equipment ground to assure continuity of connections.
 2. Remove all blocking used for shipment.
 3. Check overload relays for proper current range with motor nameplate full load amperes. Adjust relays for manual reset except where automatic reset is indicated.
 4. Check magnet coil for proper operating voltage.
 5. Clean all contacts and magnetic surfaces.
 6. Check air gap between moving and stationary magnets with manufacturer's clearances.
 7. Check all auxiliary contacts for correct arrangement with coil de-energized; i.e., normally-open or normally-closed.
 8. Megger each pole of starter for freedom from grounds or shorts.
 9. Check all circuit breakers for proper ratings.
 10. Check connectors for tightness.

11. With motor disconnected, energize control circuits and test for correct functioning.
 12. For industrial-type timing relays, adjust the timing cycle for proper equipment operation, as furnished by engineer.
 13. Check secondary fuses on motor starter control power transformer supply.
- F. Control and Instrument Switch Tests:
1. Inspect all contacts and shunts, cleaning contacts if required.
 2. Operate switch and note that all design functions are performed in proper sequence.
- G. Power Switches: (Disconnects and Automatic Transfer Switches):
1. Inspect contacts and clean if required.
 2. Inspect arc chutes if provided on switch.
 3. Operate switches (de-energized) for proper functioning.
- H. Pressure Switches, Float Switches and Limit Switches:
1. Inspect and test switches to conform to manufacturer's recommended field test.
 2. Adjust switches to perform the design function for proper equipment operation.
- I. Submersible Level Transducer:
1. Test submersible level transducer with a 4-20mA calibrator.
- J. Instruments:
1. Annunciator Tests:
 - a. Check each unit of annunciators by closing or opening the trouble contact and observing operation of control board.
 - b. Check all annunciator lamps, audible cutoff and reset operation.
- K. Wire and Cable Tests: (Feeders and Control Circuits Only):
1. Megger all 600V insulated wire with a 500V megger for one minute, and values must be approximately as follows:

Conductor Capacity In Amperes	Resistance In Ohms
0-24	1,000,000
25-50	250,000
51-100	100,000
101-200	50,000
201-400	25,000
501-800	12,000
Over 800	5,000

- a. Determine the values with all motor control centers, panelboards, switches, and overcurrent devices in place. Do not connect motors and transformers during meggering. Megger wire and cable after installation, not on the cable reel.
2. Check all control cables by megger tests similar to those described for 600V insulated wire. Check all control wiring for tightness of terminal contacts and continuity through each "run" of control circuiting. Thoroughly verify all wiring by means of battery-powered lights, buzzers, bells, or telephones. After completing these checks and tests on a given control circuit, attach a temporary cardboard tag on each end of cable tested which bears date and name of Contractor's representative responsible for checking. Follow this procedure for each control circuit cable. Provide all phasing tests and make all changes necessary to assure proper rotation of all motors, the proper polarity on all transformer wiring, and such other phasing tests as may be required for the equipment being connected under this Contract.

- L. Control Schemes Tests: Test all electrical controls by trial operation of control equipment after all wiring is completed to see that each interlock and control function operates to conform to the description of operation, as indicated on the schematic diagrams as well as with the manufacturer's operating instructions. These tests are to be coordinated with the District's Systems Integrator.
- M. Protective Relays:
 - 1. Test "Out of Case" and "In Case" (or arranged to have this done by qualified test people from a local utility or test firm) in accordance with the manufacturer's relay instruction books and instructions furnished by manufacturer's service representative.
 - 2. Out-of-Case Bench Tests:
 - a. Test each relay completely including timing, restraint, calibration, contact operation, etc., with load boxes, cycle timers, test rectifiers and any special test equipment required, all in accordance with instructions in the relay manufacturer's manuals for field testing.
 - b. Set to values furnished by the Engineer.
 - 3. In-Case Tests:
 - a. After completion of bench testing and connection of all external wiring, conduct in-case tests by manually or electrically closing each relay contact to see that proper breaker is tripped, alarm sounded, or control function operates as the drawings indicate.
 - b. Correct any errors in interconnecting wiring or internal equipment wiring as directed by the Engineer to obtain the correct operation of all relays.
- N. Thermostat Tests:
 - 1. Check operation of ambient air thermostats.
 - 2. After space heating and ventilating units and thermostat installations are complete, make an operating test on each circuit and check each heating and ventilating unit circuit for proper current flow.
- O. Temperature Devices:
 - 1. Note the temperature reading on instrument for particular point to be checked, then go to that particular thermocouple or resistance element and disconnect the leads; if point being checked is connected to correct measuring elements, no indication will be received.
 - 2. Make necessary changes to correctly connect instruments to their proper temperature sensing elements.
 - 3. Reconnect the leads.
- P. Miscellaneous Equipment Tests: Test all miscellaneous equipment furnished by equipment manufacturer as recommended by manufacturer.
- Q. Lighting Tests:
 - 1. Test all systems for proper operation and correct phasing prior to final acceptance.
- R. Grounding Tests:
 - 1. Measure resistance of ground system at each ground riser.
 - 2. Record results and notify Engineer if any reading exceeds 10 ohms.
 - 3. Test at least three of each type of ground connections and not less than 25 percent of all ground connections.
 - 4. Test by the following method for resistance measurement:
 - a. Commercial instrument method using equipment as specified in this Section.

END OF SECTION