TOWN OF LEXINGTON

WASTEWATER PUMPING STATION DESIGN GUIDELINES AND STANDARD SPECIFICATIONS

LAST REVISION:

JUNE 24, 2019

REVISIONS

DATE	NOTES
12/1/2017	Initial Draft
6/24/2019	Initial Version

PART 1 GENERAL PROVISIONS

1.1 GENERAL

1.1.1 The wastewater pump station design guidelines, standards and material specifications provided herein are based on Federal, State, and local regulations as well as the requirements of the Town of Lexington's Utilities Department.

1.1.2 The design of wastewater pump stations and related appurtenances shall be in accordance with South Carolina Department of Health and Environmental Control (SCDHEC) Regulation R.61-67 "Standards For Wastewater Facility Construction" and all current building codes and standards and development guidelines adopted by the Town of Lexington or other authorities having jurisdiction over the work.

1.1.3 These design guidelines and material specifications are applicable to all developments desiring wastewater service from the Town of Lexington.

1.1.4 The guidelines and specifications herein are intended to provide general guidance and establish minimum criteria for the design and construction of wastewater pump stations and related appurtenances. However, the pump station design is the sole responsibility of the design engineer. Any deviations from these guidelines, standards and material specifications must be approved by the Town of Lexington.

1.1.5 Standard drawings (Standard Drawings) have been prepared for use in the design of wastewater pumping stations. These standard drawings shall be considered to be a part of these wastewater pumping station design guidelines and standard specifications and shall be used by the design engineer in conjunction with the guidelines and specifications for the design of wastewater pumping stations. The standard drawings address site and pump station layout and design details as well as electrical and control design requirements and details. Following is a list of standard drawings that have been developed for wastewater pumping stations:

DRAWING TITLE	DRAWING NO.	DATE	REVISED
Site Layout	WW-1	06/10/15	--
Pump Station Elevation and Magmeter Vault Section	WW-2	06/10/15	02/05/16
Pump Station Plans and Magmeter Vault Plans	WW-3	06/10/15	--
Back-Up Pump Elevations and Level Sensor Detail	WW-4	06/10/15	--
Canopy and Electrical Pad Plan and Elevations	WW-5	06/10/15	--
Standard Details Sheet No. 1	WW-6	06/10/15	--
Standard Details Sheet No. 2	WW-7	06/10/15	--
Fencing Details	WW-8	06/10/15	--
Electrical Details Sheet No. 1	WW-9	06/10/15	--
Electrical Details Sheet No. 2	WW-10	06/10/15	--
Typical Pump Control Panel Wiring Schematics	WW-11	06/10/15	--

1.1.6 Any requested deviations from these guidelines or the Standard Drawings or material specifications will be addressed on a case by case basis by the Town.

PART 2 WASTEWATER PUMP STATION DESIGN GUIDELINES

2.1 GENERAL

2.1.1 Wastewater pump stations should be used only where gravity service is not possible.

2.1.2 When a pump station is used, the downstream receiving system must have available capacity to convey the proposed peak discharge from the station. An evaluation of the downstream system will be required in order to demonstrate that the proposed discharge will not overload the receiving system. Any upgrades that may be required to the receiving system shall be the responsibility of the customer/developer requesting the pump station.

A. When a pump station force main will discharge into a downstream gravity sewer, the downstream gravity system shall be evaluated based on the peak wastewater flow from the pump station as well as the peak flows already permitted to the downstream gravity system.

B. When the proposed pump station force main discharges into another pump station, the ability of the downstream pump station to accommodate the peak flow from the proposed pump station as well as peak flows already permitted to the downstream station shall be evaluated.

C. When the proposed pump station force main discharges into another force main, the common force main shall be evaluated based on the peak wastewater flow from the proposed station as well as the peak flow from all pump station(s) already discharging into the common force main. The ability of each pump station that discharges into the common force main to pump against the increased head created by the increased flow in the common force main shall be evaluated. In addition, the discharge point of the common force main shall also be evaluated.

2.1.3 Pump station structures and equipment shall be protected from physical damage by flooding to the one hundred (100) year flood elevation and shall be designed to be fully operational to the twenty five (25) year flood elevation.

2.1.4 An all-weather access road must be provided for access to the pump station site to include adequate room near the site for a truck turn-around. Refer to Standard Drawing WW-1 “Site Layout” for access road requirements.

2.1.5 Fencing/Signage - All wastewater pump stations shall be enclosed with a minimum six foot (6') high cyclone fence with three (3) strands of barb wire on top. A double swing gate, a minimum of twenty feet (20') wide shall be provided. An emergency sign with the emergency telephone number shall be attached to the fence. Refer to the Standard Drawings for detailed fencing and signage details and the detailed specifications in Part 2.2.6.C of the Design Guidelines.

2.1.6 Landscaping shall be provided around the perimeter of all wastewater pump stations. Refer to the Standard Drawings for landscaping requirements.

2.1.7 Alarm System - An audio-visual alarm shall be provided on all pump stations to warn of a pump malfunction. Refer to the Standard Drawings and material specifications for horn and light details.

2.1.8 Pump Removal - Stainless steel guide rails and chains shall be installed for the removal of pumps in all stations. Refer to the Standard Drawings and material specifications for details.

2.1.9 Emergency Back-Up Pumping - Provisions shall be made for providing an emergency back-up for all wastewater pump stations. Refer to the Standard Drawings and material specifications for details. Wherever backup pumping is not installed, fees will be assessed by the Town of Lexington.

2.1.10 Operation & Maintenance (O & M) Manuals - Four (4) complete sets of Operation and Maintenance manuals shall be provided for all pump stations prior to final approval. Refer to standard specifications herein for additional details and requirements for O & M Manuals.

2.1.11 Prior to final acceptance of the Pump Station by the Town, the locations of all underground piping and utilities or other components which are concealed from view shall be accurately recorded and a Record Drawing shall be provided to the Town.

2.2 DESIGN CRITERIA

2.2.1 Pump Station Capacity:

A. Minimum wastewater pumping station capacity shall be determined based on the projected peak wastewater flow that is expected for the area served by the station at build out. Peak wastewater flow shall be determined by calculating the average daily flow for the pump station and multiplying it by an hourly peaking factor as outlined below.

1. Average daily flow projections for pump stations shall be based on the type of facility that is served.
2. The minimum average daily flow for a single family residential dwelling shall be 300 gallons per day (GPD) per unit.
3. All other average daily loadings shall be determined in accordance with Appendix A – “Unit Contributory Loadings to All Domestic Wastewater Treatment Facilities” of SCDHEC Regulation R.61-67 “Standards For Wastewater Facility Construction”.
4. Peak hourly wastewater flow shall be appropriate for the service area and the typical wastewater generation patterns of the population being served.

   The minimum peak hourly wastewater flow (minimum wastewater pumping station capacity) into the pump station shall be calculated by multiplying the average daily flow by a peaking factor determined using the following equation:

$$PF = \frac{18+\sqrt{P}}{4+\sqrt{P}}$$

Where: PF = Peaking Factor

P = Service Population (Thousands)

2.2.2 Pumps:

A. All pump stations shall have a minimum of two (2) pumps. All pumps shall be of equal capacity. For duplex pump stations, each pump shall be designed to pump the peak hourly wastewater flow as calculated above, or the minimum flow required to maintain a velocity of 2.0 feet per second in the downstream force main, whichever flow is greater. For stations having three or more pumps, pumps shall be sized such that the greater of the peak hourly wastewater flow as calculated above, or the minimum flow required to maintain a velocity of 2.0 feet per second in the downstream force main, can be pumped with one pump out of service.

B. Pumps shall be selected with design operating points that are on the pump curve supplied by the pump manufacturer. Pumps that operate at unstable areas along the pump curve for any of the expected design operating conditions shall not be allowed. All points at which the pump is expected to operate shall be within the pump manufacturer's allowable operating region as defined in ANSI/Hydraulic Institute Standard 9.6.3-2012 "Rotodynamic (Centrifugal and Vertical) Pumps - Guideline for Allowable Operating Region". Pumps that operate at very low flow and high head, near "shutoff" head, or at "runout" conditions (maximum possible flowrate of the pump) will not be acceptable.

C. Pumps shall have a design operating point that is at or near peak efficiency whenever possible and shall be selected such that their operating efficiency is maximized under all design operating conditions that exist or may exist over the life expectancy of the pump station.

D. The selected pump shall have a net positive suction head available (NPSHA) that is greater than the net positive suction head required (NPSHR) for the pump at the design operating point(s).

E. Pumps shall be designed for continuous duty and to pump raw, unscreened sewage and/or other fibrous pumpage without damage during operation.

F. Pumps shall be of a non-overloading design, such that the pump shaft horsepower (BHP) shall not exceed the motor rated horsepower throughout the entire operating range of the pump performance curve.

G. Pumps controls shall be designed so that the pumps operate in an alternating lead/lag sequence.

H. All pumps shall be capable of passing a sphere of at least 3-inches in diameter. Pump discharge piping shall have a minimum diameter of 4-inches.

   1. The Town of Lexington may consider the use of grinder pumps as an alternative to the pumps specified herein in certain situations. In the event that grinder pumps are allowed, a minimum discharge size of 2-inches is required.

I. Pumps shall be provided as specified herein and as shown on the Standard Drawings. Pump arrangement/piping shall be as indicated on the Standard Drawings.

2.2.3 Wetwell:

A. Pump station wetwells shall be as specified herein and as shown on the Standard Drawings. Wetwell structure shall be constructed of reinforced concrete and shall be designed and constructed to be as hazard free as possible with corrosion resistant materials used throughout.

B. The wetwell shall be of sufficient size and depth to accommodate the influent wastewater and provide the required depth of submergence as recommended by the Hydraulic Institute Standards. The required working volume shall be determined using the following formula with a minimum cycle time (time between pump starts) of 10 minutes (six pump starts per hour) unless otherwise approved by the Town:

$$V = \frac{(Q_P * C_t)}{4}$$

Where, V = Wet well volume between lead pump start and stop elevations (Gallons)

Qp = Maximum pumping rate (GPM), and

Ct = Minimum cycle time (Minutes). Note: The minimum cycle time is 10 minutes unless a longer cycle time is required by pump manufacturer.

C. The minimum allowable wetwell diameter shall be 8'-0" unless otherwise permitted by the Town.

D. The wetwell floor shall be sloped from the sides of the walls to the pumps.

E. Adequate ventilation shall be provided for all wetwells. At a minimum, wet wells shall have a vent made from ductile iron pipe with flanged joint pipe fittings as shown on the Standard Drawings. Provide a screened vent, sized by the design engineer for the wet well and installed so that gases are directed away from equipment. The vent shall be 6-inch diameter minimum size and supplied with an aluminum insect screen. Vent shall be sized so that not more than ½ inch of static pressure or vacuum is applied to the structure at the peak pump station design flow.

F. Wetwell and other below ground structures shall be designed to prevent flotation resulting from the buoyant forces of groundwater. The design engineer shall provide buoyancy calculations to demonstrate that the wetwell and other below ground structures are protected from flotation with a factor of safety of 1.5.

1. Buoyancy calculations shall be performed based on the assumption that the groundwater elevation is equal to the ground elevation adjacent to the wetwell.

G. Concrete wetwell shall be epoxy lined as specified herein and as shown on the Standard Drawings. Piping inside of wetwell shall also be coated with same epoxy liner.

H. Access hatch and frame shall be located in top slab of wetwell and shall be of aluminum fabrication. Hatch shall be properly sized for removal of submersible pumps with 6-inch minimum clear spacing between pump and hatch opening on all sides. Refer to Standard Drawings for details.

I. Wetwell Level Settings:

1. Distance between the "PUMPS OFF" elevation and the "LEAD PUMP ON" elevation: As determined from the wetwell volume (V) calculated above and the wetwell diameter;

2. Distance between the "LEAD PUMP ON" elevation and the "LAG PUMP ON" elevation: 6-inches minimum;

3. Distance between the "LAG PUMP ON" elevation and the "HIGH LEVEL ALARM" elevation: 6-inches minimum (Note: If station contains more than two pumps, pump on elevations for each additional pump shall be 6-inches minimum above the previous pump on elevation);

4. Distance between the "HIGH LEVEL ALARM" elevation and the inlet pipe invert elevation: One (1) foot minimum;

2.2.4 Valve Vault

A. Provide a below grade concrete valve vault as indicated on the Standard Drawings.

B. Valve vault shall be sized as indicated on the Standard Drawings and shall include a swing check valve and plug valve for each pump along with an air/vacuum valve, pressure gauge, associated fittings, and floor drain. Refer to Standard Drawings for details.

C. Valve vault floor shall have a slight slope toward the floor drain. Floor drain shall have a drain pipe back to the wetwell with a "duckbill" type valve inside of the wetwell. All piping and valves inside of the valve vault shall be painted as specified herein.

D. Access cover for valve vault shall be of aluminum fabrication and shall be properly sized for removal of valves/piping. Refer to Standard Drawings for details.

2.2.5 Magnetic Flow Meter (Magmeter) Vault

A. Provide a below grade concrete magmeter vault as indicated on the Standard Drawings.

B. Magmeter vault shall be sized as indicated on the Standard drawings and shall include a magnetic flow meter and associated piping and electrical appurtenances.

C. Magmeter vault floor shall have a slight slope toward a floor drain. Floor drain shall have drain piping that connects to the valve vault drain.

D. Access cover for magmeter vault shall be of aluminum fabrication and shall be properly sized for removal of magnetic flow meter. Refer to Standard Drawings for details.

E. All piping inside of the magmeter vault shall be painted as specified herein.

2.2.6 Pump Station Site

A. Pump station site layout shall be as indicated on Standard Drawing WW-1 "Site Layout". Minimum property size shall be 70 feet x 70 feet for stations adjacent to a public roadway. If the station is not located adjacent to a public roadway, the minimum property size shall be 70 feet x 120 feet to permit room for a truck turn around and the site shall have a 32 foot wide access corridor extending to the nearest public roadway.

B. Pump station site shall meet all land development, zoning and landscaping regulations of the Town of Lexington or Lexington County (when located outside of Town Limits).

C. Site Security: Pump Station site shall be fenced with 6 foot high green vinyl coated, galvanized chain link security fencing with green PVC privacy slats as specified herein and as shown on the Standard Drawings. Provide 20 foot wide double swing drive gate located as shown on Standard Drawings. Fence shall include three (3) strands of vinyl coated barbed wire to match color of fence fabric.

   1. Provide emergency sign with 24-hour contact telephone number and attach to entrance gate. Sign shall be in accordance with the detail on the Standard Drawings.

D. Fenced areas along with access road and truck turnaround/parking area shall have 6-inches of crusher run with a geotextile fabric underlayment. Provide minimum 20 foot wide all weather access road for remote pump stations.

E. The top of the wetwell slab and the wet well vent shall be a minimum of one (1) foot above the FEMA 100-year flood elevation for the site. The 100-year flood elevation shall be determined using the most recent FEMA Flood Insurance Rate Map.

F. Top elevation of wetwell slab as well as all other concrete slabs onsite shall be set to provide positive drainage away from the station and minimize flooding. At a minimum, top of slabs shall be 6-inches above surrounding grade.

G. Provide yard light with photo cell control as indicated on the Standard Drawings.

H. Where available, potable water shall be provided at the pump station site. Provide water meter box, backflow prevention device, frost proof yard hydrant and appurtenances as detailed on the Standard Drawings.

I. Provide a receiving manhole on the influent gravity sewer line within the site security fence and as shown on the Standard Drawings.

J. Provide a bypass connection, located as shown on the Standard Drawings.

K. Provide a permanent back-up pump as detailed on the Standard Drawings and specified herein.

L. Provide a generator receptacle and manual transfer switch. Refer to Standard Drawings.

M. Overhead power lines will not be allowed to cross the pump station site.

2.2.7 Site Piping:

A. Pipe material shall be as indicated on the Standard Drawings and as specified herein.

B. All exposed piping shall be painted.

2.2.8 Electrical/Controls

A. All materials and work associated with the pump station shall comply with the latest edition of the National Electric Code (NFPA 70), NFPA 820 – "Standard For Fire Protection In Wastewater Treatment and Collection Facilities" and all other applicable state and local codes and regulations.

B. Electrical service shall be designed to accommodate the ultimate capacity of the pump station and with both pumps running at one time. Coordinate electrical service design with the local electric utility.

C. All materials shall be new and shall conform with the requirements of the Underwriters' Laboratories, Inc. (UL), American National Standards Institute (ANSI), National Electrical Manufacturers' Association (NEMA), Insulated Cable Engineers Association, and Institute of Electrical and Electronics Engineers in every case where a standard has been established.

D. All electrical and control panels shall be NEMA 4X rated and lockable as specified herein and on the Standard Drawings.

E. Refer to Standard Drawings for typical electrical rack equipment layout. Alternate arrangements must be approved by the Town of Lexington. Equipment mounted to electrical rack shall include: Utility meter (where permitted by utility); main disconnect switch; transient voltage surge suppressor; SCADA RTU; pump control panel; manual transfer switch; generator receptacle; and other equipment and appurtenances as required.

F. Electrical equipment and system components located in and adjacent to wetwell shall comply with the requirements for Class 1, Division 1/Class 1, Division 2 service as defined in NFPA 820.

G. The pump station control panel shall be located as shown on the Standard Drawings and at least 5'-0" away from the wetwell hatch opening. Electrical/Control conduits between the control panel and wetwell shall be protected by conduit seals or other appropriate measures meeting the requirements of the NEC and NFPA 820 to prevent the migration of hazardous gases into the control panel.

H. All electrical conductors and control wiring and cables from the wetwell shall be terminated in a 316 SS NEMA 4X rated junction box, allowing disconnection from outside of the wetwell. Junction box shall be as specified herein and on the Standard Drawings.

I. All electrical equipment shall be located 2 feet (minimum) above the 100 year flood elevation.

J. Electrical equipment rack shall be of sufficient size to accommodate all electrical and control equipment (including SCADA equipment). Refer to Standard Drawings for layout and minimum size requirements.

K. Electrical equipment rack shall be fabricated entirely of 316 Stainless Steel components and hardware and shall be covered by an aluminum canopy. Refer to Standard Drawings for canopy requirements and design details. Provide concrete pad for electrical equipment as detailed on the Standard Drawings.

L. All electrical/control equipment subject to vibration shall be connected with a section of sealtite flexible conduit.

M. All conduit penetrations shall be made through the bottom of panels.

N. The pump station shall be provided with a telemetry system RTU for remote monitoring and control of all pump station equipment through the Town of Lexington's SCADA system. RTU shall be housed in a NEMA 4X rated fiberglass or stainless steel enclosure.

O. The telemetry equipment, including the RTU, antenna, and antenna pole shall be provided and installed by the Town of Lexington's SCADA system integrator. For coordination of latest telemetry requirements, contact: Collins Controls, Inc., 162 Country Woods Road, Lugoff, SC 29078, Phone: (803) 438-9943.

P. Extend conduits inside wet well to hatch opening for ease of access. Provide strain relief grips on all cables inside wet well hanging on cable rack.

Q. All control wiring shall be marked at both ends with permanent plastic wire markers.

R. The conduit system, all electrical equipment, all steel structures, motor frames, etc. Shall be connected to the grounding system per article 250 of the National Electric Code.

S. Provide phenolic nameplates as required for equipment labeling.

T. Conduits to be labeled with phenolic name plates attached to conduits with stainless steel wire.

U. Where permitted by electrical utility, install electrical service meter on electrical rack inside of fenced area. Where electrical utility will not allow the meter to be placed on the electrical rack or inside of the fenced area, install the meter on a service pole, located outside of the fenced area, as shown on the Standard Drawings.

V. Variable Frequency Drives (VFDs) are required for all pump motors unless permitted otherwise by the Town of Lexington. For pump station sites where three phase utility power is unavailable, VFDs shall be sized and specified to convert the single phase input power into three phase output power to pump motors.

W. Control panels with PLC(s) and/or VFD(s) shall include air conditioning to remove heat produced by VFD(s), PLC(s) and ambient conditions. Provide air conditioning unit(s) with factory applied corrosion resistant coil coating.

PART 3 PUMP STATON MATERIAL SPECIFICATIONS

3.1 GENERAL PROVISIONS

3.1.1 The following material specifications are provided for pump stations and associated appurtenances. All materials used in the construction of the pump station and associated appurtenances must conform to these requirements.

3.1.2 All materials and equipment shall be of good quality and new. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with instructions of the applicable supplier, unless noted otherwise.

3.2 PRECAST CONCRETE WET WELLS AND VAULTS

3.2.1 GENERAL

A. Section Includes: Monolithic or sectional precast concrete utility structures, including wetwells, vaults, pipe connectors, and accessories.

B. References:

1. AASHTO M198 – Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets.
2. ACI 318 – Building Code Requirements for Reinforced Concrete.
3. ASTM C33 – Concrete Aggregates.
4. ASTM C150 - Portland Cement.
5. ASTM C260 - Air Entraining Admixtures for Concrete.
6. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
7. ASTM C494 - Chemical Admixtures for Concrete.
8. ASTM C618 - Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
9. ASTM C890 - Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
10. ASTM C891 - Installation of Underground Precast Concrete Utility Structures.
11. ASTM C913 - Precast Concrete Water and Wastewater Structures.
12. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
13. OSHA 1926.704 – Requirements for Precast Concrete.
14. National Precast Concrete Association: Quality Control Manual for Precast Concrete Plants.
15. Prestressed Concrete Institute: Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

C. Submittals For Review:

1. Certificate sealed by a Registered Professional Engineer on the staff of the Manufacturer stating that the materials and manufacturing of the precast concrete components meets the requirements of this Section.
2. Certificate or Report showing that the Manufacturer meets the requirements of this Section.
3. Schedule of Precast Concrete Components:
   a. Drawing sheet number where the structure plan and profile are shown.
   b. Precast structure number, station number, or application description.

c. Invert elevation of the influent and effluent pipes as shown on the Drawings.

d. Top and bottom elevation of the precast structure as shown on the Drawings.

e. Total height for the individual and assembled precast components.

f. Manufacturer's Part No. or Catalogue No. and quantity of each base, riser, and top to be provided.

g. Pipe connector size, Part No. and location.

h. Other opening or cast-in item descriptions and locations.

4. Detail of Precast Concrete Components, sealed by the Registered Professional Engineer:

a. Manufacturer's Part No. or Catalogue No.

b. Interior dimensions and lay length.

c. Wall thickness and base or top thickness where applicable.

d. Handling weight and lifting component information.

e. Wire size, spacing, location and steel area per vertical foot.

f. Reinforcing bar grade, size, spacing, and location.

g. Design loads.

h. Concrete Mix No. and design strength.

i. Height, width, slope and annular space of the tongue & groove at joint locations.

5. Pipe connector details, specifications, and installation procedure.

6. Joint material detail, specifications, and dimensions.

7. Upon request, submit the following:

a. Structural analysis and design calculations for precast components, performed in accordance with applicable codes and standards, showing that allowable stresses will not be exceeded. All calculations must be sealed by a Registered Professional Engineer employed by the Manufacturer.

b. Calculations or test results verifying that the lifting device components and holes are designed in accordance with OSHA Standard 1926.704.

c. Concrete 28 day compression strength results for every day production of precast components for the project was performed, showing the required strength according to the guidelines established in ACI 318.

d. Reinforcing and cement mill reports for materials used in the manufacture of precast components for this project.

D. Qualifications

1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

2. Manufacturer’s certification requirements:
   a. Prestressed Concrete Institute's (PCI) Plant Certification Program, or
   b. National Precast Concrete Association's (NPCA) Plant Certification Program
3. The Manufacturer shall have a recognized Quality Improvement Process implemented at the manufacturing facility.
4. The Manufacturer shall employ at least one Registered Professional Engineer at the manufacturing facility.
5. Concrete compressive strength testing shall be performed in a laboratory inspected by the CCRL of the National Bureau of Standards. Testing shall be performed by Grade I ACI Certified Laboratory Technicians or by Level I PCI Certified Technicians.

E. Environmental Requirements:

1. Maintain materials and surrounding air temperature to minimum 50 degrees F (10 degrees C) prior to, during, and 48 hours after completion of masonry work.

3.2.2 PRODUCTS

A. Materials

1. Concrete shall conform to ASTM C478 and the following:
   a. Water: Clean, potable, free from deleterious material, and not detrimental to concrete.
   b. Air content: 4 percent minimum.
   c. Portland cement: ASTM C150, Type I or Type III.
   d. Coarse aggregates: ASTM C33. Size #57.
   e. Fine aggregates: ASTM C33.
   f. Chemical admixtures: ASTM C494. Calcium chloride or admixtures containing calcium chloride shall not be used.
      i Type A - Water Reducing
      ii Type B - Retarding
      iii Type C - Accelerating
      iv Type D - Water Reducing and Retarding
      v Type E - Water Reducing and Accelerating
      vi Type F - Water Reducing, High Range
      vii Type G - Water Reducing, High Range and Retarding
   g. Air entraining admixtures: ASTM C260.
   h. Fly ash, calcinated Pozzolan: ASTM C618.
   i. Compressive strength: 5,000 psi at 28 days.

2. Reinforcing steel shall be ASTM A615 grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.
3. Structural steel plates, angle, etc. shall be ASTM A36.
4. Lift loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars are not allowed.
5. Butyl rubber sealant shall conform to Federal Specification SS-S-210A, AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 degrees F.
6. Butyl rubber with bentonite sealant shall contain 99% solids with a maximum of 1% volatile matter and suitable for application temperatures between 5 and 125 degrees F.
7. Epoxy gels used for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive meeting ASTM C-881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.
8. Pipe penetrations shall be sealed with a neoprene boot of 3/8 inch minimum thickness conforming to ASTM C923 or non-shrink grout. Boots shall be either cast into the wall or installed into a cored hole using internal compression rings. Installed boot shall result in a watertight connection meeting the performance requirements of ASTM C443.

B. Components

1. Precast component fabrication and manufacture shall be as described below:
   a. Precast manufacturing shall be in conformance with ASTM C913. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable. Form ties installed through the wall of the product are not allowed. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, and minor depressions, chips and spalls will be tolerated, but major imperfections, honeycombs or other defects shall be properly repaired.
   b. Joint surfaces on joints between precast structure components shall be keyways or tongue and grooves manufactured to the joint surface design and tolerance requirements of ASTM C913.
   c. Lift inserts and holes shall be sized for a precision fit with the lift devices, shall conform to OSHA Standard 1926.704, and shall not penetrate through the precast structure wall.
   d. The structural design of precast components shall be in accordance with applicable codes and standards. No less than 80 psf per foot of depth of equivalent fluid pressure should be used for lateral earth design loads plus the lateral surcharge design loads possible from HS-20 traffic. Vertical design loads shall include structure dead loads, earth loads, hydrostatic loads, and traffic live loads where applicable with no less than

300 psf live load. The empty and liquid full container conditions shall both be considered.

2. Precast base sections shall be either cast monolithically without construction joints or with an approved PVC waterstop cast in the cold joint between the base slab and the walls. Where shown on the Drawings, base section slab extensions shall be provided on the short sides of the base slab. The width of the extensions shall be the slab thickness unless shown different.
3. The minimum lay length of precast riser sections shall be 36 inches.
4. Precast top sections shall be either cast monolithically without construction joints or with an approved PVC waterstop cast in the cold joint between the top slab and the walls. Joints cast on top sections for round manhole transition assemblies shall have ASTM C361 joint surfaces.
5. Pipe to precast structure connectors shall conform to ASTM C923.
6. Joints between precast components shall be sealed with a polyethylene backed flat butyl rubber sheet no less than 1/16 inch thick and 6 inch wide applied to the outside perimeter of the joint. Joints shall also be sealed internally, with a sealant having a cross-sectional area no less than the joint length times the joint height, as follows:
   a. Butyl rubber sealant in joints with perimeters less than 18 feet.
   b. Bentonite impregnated butyl rubber sealant in all other joints.
7. Frames, covers, grates, and hatches shall be as shown on the Standard Drawings.
8. Lifting devices for handling precast components shall be provided by the Manufacturer and shall comply with OSHA Standard 1926.704.
9. Coatings: As shown on the Standard Drawings, the interior of the precast structure walls shall be coated as indicated. The coating shall be spray applied according to the manufacturer's recommendations by an applicator with a minimum of 5 years of experience. Exterior surfaces of wet well and vault piping shall be also be coated as indicated on the Standard Drawings.

C. Configuration

1. Precast concrete structures are to be constructed as specified and as shown on the Standard Drawings.
2. The number of joints is to be minimized. Use no more than 2 sections up to 8' of depth and no more than 1 additional section for each 4' of depth.

3.2.3 EXECUTION

A. Examination

1. Inspect precast components prior to unloading to verify correctness.
2. Verify items provided under other specification sections are properly sized and located.

3. Verify that built-in items are in proper location, and ready for roughing into work.
4. Verify excavation for precast structures is correct.

B. Product Handling

1. Coordinate delivery with the Manufacturer, handle, and store the precast components in accordance with ASTM C891 and the Manufacturer's recommendations using methods that will prevent damage to the components and their joint surfaces.

C. Installation

1. Excavation for all precast structures shall be carried to a depth as to provide a minimum of 12 inches of Fill Type A2 under base section and extend a minimum of 12 inches beyond each side of the structure unless otherwise shown on the Drawings. Should unstable soil, organic soil, or soil types classified as fine-grained soils (silts and clays) by ASTM D2487 be encountered at the bottom of excavations, such soils shall be removed to a depth and width determined and approved by the Town, and properly disposed of. The resulting undercut shall be backfilled with Fill Type A2.
2. Place precast structure sections plumb and level to insure a uniform bearing at all joints and base slab. Joints shall be thoroughly cleaned to remove dirt and foreign material. The butyl rope sealant shall be unrolled directly against the base of the spigot. Leave the protective paper in place until the sealant is fully in place. Overlap rope from side to side, not top to bottom. Joints to be plastered smooth inside and outside of manhole with a cement grout. Joints shall be watertight.
3. Set risers and tops, aligning internal wall surfaces, so that proper alignment is achieved, taking particular care to clean, prepare and seal joints. Align any pipe openings with pipe inverts.
4. After joining precast sections, apply the butyl sealant sheet around the outside perimeter of the joints below grade.
5. Secure pipe connectors to pipe according to the Manufacturer’s instructions. When pipe stub outs are installed, provide restraint from longitudinal movement before backfill.
6. Lift holes leaving less than 2" of wall thickness shall be plugged from the outside using a sand cement mortar and then covered with butyl sealant sheet. Lift holes penetrating the wall shall be additionally sealed with an interior application of an epoxy gel 1/8" thick extending 2" beyond the penetration.
7. Vacuum test the assembled precast structure after completing pipe connections and sealing but before backfilling when required by the Town as follows:
    a. Plug pipes with suitably sized and rated pneumatic or mechanical pipeline plugs. Place plugs a minimum of 6" beyond the precast wall and brace to prevent displacement of the plugs or pipes during testing. Seal other openings as required.

b. Position the vacuum tester head assembly to seal according to the Manufacturer's recommendations.

c. Draw a vacuum of 10 in-Hg, close the valve on the vacuum line, and shut off the vacuum pump.

d. Measure the time for the vacuum to drop to 9 in-Hg. The precast structure shall pass when the time to drop to 9 in-Hg meets or exceeds the following:

Floor Area (ft^2)	20	50	80	120	160	200
Seconds	30	45	60	75	90	105

e. If the structure fails the test, remove the head assembly, coat the interior with a soap and water solution, and repeat the vacuum test for approximately 30 seconds. Leaking areas will have soapy bubbles. Make the necessary repairs and repeat the test until the test is made.

8. Depressions, high spots, voids, chips or fractures over 1/4 inch in diameter or depth shall be corrected using sand cement and finished to a texture conforming to the formed surface.

9. Coordinate with other sections of work to provide a complete installation.

3.3 PRECAST CONCRETE MANHOLES

3.3.1 GENERAL

A. Section Includes: Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage, pipe connections and accessories.

B. References

1. ASTM A48 - Gray Iron Castings.
2. ASTM C55 Concrete Building Brick.
3. ASTM C62 Building Brick (Solid Masonry Units Made From Clay or Shale).
4. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
5. ASTM C890 - Standard Practice for Min. Structural Design Loading for Monolithic/Sectional Precast Concrete Water and Wastewater Structures.
6. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
7. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
8. ASTM C990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.
9. ASTM C1244 – Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
10. American Concrete Institute: Building Code Requirements for Reinforced Concrete (ACI 318).
11. Occupational Safety and Health Administration: Standard 1926.704 – Requirements for Precast Concrete.
12. IMIAC International Masonry Industry All Weather Council: Recommended Practices and Guide Specification for Cold Weather Masonry Construction.
13. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

C. Submittals For Review

1. Shop Drawings: Indicate manhole locations, elevations, piping, sizes and elevations of penetrations.
2. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.

D. Qualifications

1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience. Precast

plant shall be certified by the National Precast Concrete Association (NPCA) plant certification program.

E. Environmental Requirements:

1. Maintain materials and surrounding air temperature to minimum 50 degrees F (10 degrees C) prior to, during, and 48 hours after completion of masonry work.

F. See Standard Drawings for additional details.

3.3.2 PRODUCTS

A. Materials

1. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 and as follows:

   a. Compressive strength: 5000 psi minimum at 28 days.

   b. Air Content: 4% minimum.

   c. Alkalinity: Adequate to provide a Life Factor, Az = Calcium Carbonate Equivalent times Cover over Reinforcement, no less than 0.35 for bases, risers and cones.

   d. Cementitious Materials: Minimum of 564 lb/yd3.

   e. Coarse Aggregates: ASTM C33. Angular Granitic Stone only. Smooth or rounded stone shall not be used.

   f. Fine Aggregates: ASTM C33. Free from organic impurities.

   g. Chemical Admixtures: ASTM C494. Calcium Chloride or admixtures containing calcium chloride shall not be used.

   h. Air Entraining Admixtures: ASTM C260.

2. Reinforcing steel shall be ASTM A615 grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.

3. Lift loops shall be ASTM A416 steel strand or inserts designed for handling purposes. Lifting loops made from deformed bars shall not be used.

4. Flexible Joint Sealants shall be butyl rubber based conforming ASTM C990 with a maximum of 1% volatile matter and suitable for application temperatures between 10˚F and 100˚F.

5. Epoxy Gels for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high strength, structural epoxy paste adhesive meeting ASTM C-881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.

6. Manhole sections shall be designed to resist earth loads and to resist uplift resulting from buoyant forces calculated at a minimum with ground water table at the ground surface (or higher where local conditions dictate). All wall and base dimensions shall be increased accordingly to insure that the manhole does not float under these conditions.

7. Manhole Tops: Unless otherwise noted, all manhole tops shall be eccentric cones where depth of cover permits and flat slab tops where depth of cover does not permit the use of an eccentric cone.
8. Manhole Bottoms: Shall be integrally cast unless the Contractor proposes to use specialty bases ("Dog-House") at points of connection to existing sewer mains. Any special bases or risers used must be detailed in shop drawings and submitted for approval. Manhole wall and base dimensions shall conform to ASTM C478.
9. Mortar: Type S.
10. Reinforcement: Formed steel wire.

B. Components

1. Precast component fabrication and manufacture shall be as described in this paragraph and as described in the paragraphs for the specific components.
   a. Precast Manufacturing shall be in conformance with ASTM C478. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks and minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate References and specified below.
   b. Joint Surfaces between Bases, Risers and Cones shall be manufactured to the joint surface design and tolerance requirements of ASTM C361. The maximum slope of the vertical surface shall be 2 degrees. The maximum annular space at the base of the joint shall be 0.10 in. The minimum height of the joint shall be 4 in.
   c. Lift Inserts and Holes shall be sized for a precision fit with the lift devices, shall comply with OSHA 1926.704 and shall not penetrate through the manhole wall.
   d. Step holes shall be cast or drilled in the Bases, Risers and cones to provide a uniform step spacing of 16 in. Cast step holes shall be tapered to match the taper of the steps.
2. Precast Base Sections shall be cast monolithically without construction joints or with an approved galvanized or PVC waterstop in the cold joint between the base slab and the walls.
3. Precast Riser Sections shall have a minimum lay length of 16 in.
4. Precast concentric and eccentric cone sections shall have an inside diameter at the top of 24 in. The width of the top ledge shall be no less than the wall thickness required for the cone section. Concentric cones shall be used only for Shallow Manholes.
5. Precast Transition Cone Sections shall provide an eccentric transition from 60 in. and larger manholes to 48-in. diameter risers, cones and flat slab top sections. The minimum slope angle for the cone wall shall be 45 degrees.

6. Precast Transition Top Sections shall provide an eccentric transition from 84 in. and larger manholes to 48-in. diameter risers, cones and flat slab top sections. The maximum amount of fill over the transition top section shall be 20 ft. transition tops shall not be used in areas subject to vehicle traffic.

7. Precast Flat Slab Top Sections shall have an inside diameter at the top of 24 in. and shall be designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into special flat slab tops shall be sized to fit within the manhole ID and the top and bottom surfaces.

8. Precast Grade Rings shall be used to adjust ring and covers to finished grade. No more than 10 vertical in. of grade rings will be allowed per manhole. Grade Rings shall conform to ASTM C478 and shall be no less than 4 in. in height.

9. Precast inverts shall meet the following requirements:

   a. Channel depth shall be a minimum of three-fourths the pipe diameter, channel width shall be a minimum of the pipe diameter and channel outside bending radius shall be a minimum of 1.5 times the pipe diameter. Invert channels shall be formed or cored and finished to provide a consistent slope through the manhole. The minimum concrete thickness between the invert and the bottom of the base shall be 6 in. where inverts are cast monolithically with the base and 8 in. where inverts are cast secondary to the base.

   b. Invert Benches shall have a uniform finish with a uniform ½-in./ft slope. A ¼-in. to ½-in. radius shall be provided at the edge of the bench and trough.

   c. Pipe openings shall provide clearance for pipe projecting a minimum of 2 in. inside the manhole. The height of the transition from the pipe opening to the invert trough shall allow for positive flow through the manhole. Pipe openings for Service lines shall be located above the invert bench. Pipe openings for secondary pipe connections shall allow for influent pipe crowns to match unless higher elevations are shown on the Plans.

   d. Depressions, high spots, voids, chips or fractures over ¼-in. diameter or depth shall be filled with a sand cement paste and finished to a texture consistent with that of the formed surface.

10. Steps shall be provided in bases, risers, cones, transition cones and transition top sections aligned vertically on 16-in. centers. Steps shall be secured to the wall with a compression fit in tapered holes or cast in place. Steps shall not be vibrated or driven into freshly cast concrete or grouted in place. The steps shall be Copolymer Polypropylene Plastic reinforced with a ½-in. diameter grade 60 bar and have serrated tread and tall end lugs. Step pullout strength shall be 2,000 lb minimum when tested according to ASTM C497. Minimum design load of steps shall be a single concentrated load of 300 pounds. Steps shall be nine inches in depth and at least twelve inches in width. Steps shall have a non-skid top surface. Steps shall be embedded in the wall a minimum of four inches in either cast or drilled holes. Each step shall project a minimum of five inches from the wall measured from the point of embedment.

11. Pipe-To-Manhole Connectors shall be the standard mechanical boot type connector, conforming to ASTM C923, which allows for the expansion ring at the manhole wall to be completely seated in a vertical plane in the manhole wall. Compression type connectors shall not be used.

12. Joints between Precast Components shall be sealed internally between the tongue and the groove and additionally around the external perimeter as follows:

    a. External Seals shall consist of a polyethylene backed flat butyl rubber sheet no less than 1/16-in. thick and 6-in. wide applied to the outside perimeter of the joint.

    b. Internal Seals shall consist of a plastic or paper-backed butyl rubber rope no less than 14-ft long and having a cross-sectional area no less than the annular space times the height of the joint.

    c. Internal Seals may consist of an O-Ring Gasket conforming to ASTM C443, installed according to the Precast Manufacturer's recommendation.

13. Lid and Frame: Unless otherwise indicated on the Drawings, Manhole Lid and Frame shall meet the following specifications: ASTM A48, Class 35B Cast iron construction suitable for Highway Traffic Loads, machined flat bearing surface, removable lid, closed lid design; lid molded with "Sanitary Sewer" manufactured by US Foundry or equal.

C. Configuration

1. Round manhole bases shall be sized to allow for proper seat of standard mechanical boot type pipe to manhole connectors, conforming to ASTM C923.

2. The number of joints shall be minimized. Riser sections shall not be used on manholes up to 8-ft deep and no more than one (1) riser shall be allowed for each additional 6 ft in depth. One additional section will be allowed for transition manholes.

3. Construct Drop Manhole Connections where the difference in invert elevations between the influent and effluent pipes is greater than 24 in. and 2.5 times the influent pipe diameter.

3.3.3 EXECUTION

A. Preparation

1. Coordinate placement of inlet and outlet pipes from manhole.

B. Placing Manhole Sections

1. Excavation for all manholes shall be carried to a depth as to provide a minimum of 6 inches (unless a higher minimum depth is indicated on the Drawings) of fill under base section and extend a minimum of 12 inches beyond each side of the structure. Should unstable soil, organic soil, or soil types classified as fine-grained soils (silts and clays) by ASTM D2487 be encountered at the bottom of excavations, such soils shall be removed

and properly disposed of and the resulting undercut shall be filled with a suitable material.

2. Secure pipe connectors to pipe according to the connector manufacturer instructions. When pipe stub outs are installed, provide restraint from longitudinal movement before backfill.

3. Place manhole sections plumb and level to insure a uniform bearing at all joints and base slab. Joints shall be thoroughly cleaned to remove dirt and foreign material that may prevent sealing. Unroll the Butyl Sealant rope directly against base of spigot. Leave protective wrapper attached until sealant is entirely unrolled against spigot. Do not stretch. Overlap from side to side not top to bottom. Follow Manufacturer instructions when using O-rings.

4. Set risers and cones so that steps align, taking particular care to clean, prepare and seal joints.

5. After joining manhole sections, apply the butyl sealant sheet around the outside perimeter of the joint.

6. Lift Holes resulting in less than 2 in. of wall thickness shall be plugged from the outside using a sand cement mortar, then covered with butyl sealant sheet. Lift Holes penetrating the wall shall be additionally sealed with an Interior application of an epoxy gel 1/8-in. thick extending 2 in. beyond the penetration.

7. Invert channels shall be smooth and accurately shaped to a semi-circular bottom conforming to the inside of the adjacent sewer sections. Inverts shall be formed of concrete, and laying pipe through manholes will not be permitted. Changes in size and grade shall be made gradually and evenly. The minimum bending radius of the trough centerline shall be 1.5 times the pipe I.D. All pipes shall project inside the manhole two inches and be mechanically sealed with a molded neoprene boot.

8. Depressions, high spots, voids, chips or fractures over 1/4 inch in diameter or depth shall be corrected using sand cement and finished to a texture conforming with the formed surface.

9. Set manholes, frames and covers level without tipping, to correct elevations. Precast concrete manholes shall be furnished to provide a completed assembly that is flush with the finished grade or placed at grades as shown on the plans. No manhole assembly will be accepted that will allow surface water inflow to occur through the cover.

10. Precast adjustment grade rings shall be used as required. No more than 8 vertical inches of grade ring will be allowed per manhole.

C. Quality Control

1. Vacuum test the assembled manhole after completing pipe connections and sealing but before backfilling or placing frame and cover as follows:

a. Plug pipes with suitably sized and rated pneumatic or mechanical pipeline plugs. Place plugs a minimum of 6 in. beyond the manhole wall and brace to prevent displacement of the plugs or pipes during testing.

b. Position the vacuum tester head assembly to seal against the interior surface of the top of the cone section and inflate according to the manufacturer's recommendations.

c. Draw a vacuum of 10 in. of mercury, close the valve on the vacuum line and shut off the vacuum pump. Measure the time for the vacuum to drop to 9 in. of mercury. The manhole shall pass when the time to drop to 9 in. of mercury meets or exceeds 60 seconds.

d. If the manhole fails the test, remove the head assembly, coat the manhole interior with a soap and water solution and repeat the vacuum test for approximately 30 seconds. Leaking areas will have soapy bubbles. Make the necessary repairs and repeat the test until the manhole passes.

3.4 PIPING, VALVES AND ACCESORIES

3.4.1 GENERAL

A. Section Includes: Pump station piping, valves, and appurtenances as shown on the Drawings, specified herein, and as needed for a complete and proper installation.

B. References

1. ANSI A21.10/AWWA C110 – Ductile Iron and Gray Iron Fittings.
2. ANSI A21.11/AWWA C111 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
3. ANSI A21.15/ AWWA C115 – Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
4. ANSI A21.50/AWWA C150 – Thickness Design of Ductile Iron Pipe.
5. ANSI A21.51/AWWA C151 – Ductile Iron Pipe Centrifugally Cast.
6. ANSI A21.53/AWWA C153 – Ductile Iron Compact Fittings.
7. ANSI/AWWA C508 - Swing-Check Valves for Waterworks Service, 2 Inch through 24 Inch NPS.
8. ANSI/AWWA C509 - Resilient Seated Gate Valves for Water Supply Service.
9. ANSI/AWWA C515 – Reduced Wall, Resilient Seated Gate Valves for Water Supply Service.
10. ANSI/AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.
11. ANSI/AWWA C600 – Installation of Ductile Iron Mains and Their Appurtenances.

C. Submittals For Review

1. Product data: Provide manufacturer's specifications, shop drawings showing sectional views, dimensions, end connections, operator details and other data needed to demonstrate compliance with the specified requirements.
2. Certified pipe tests:
   a. Pipe materials shall be tested in accordance with the requirements for the applicable material as specified in this Section.
   b. Certified records of tests performed by the manufacturer or by an approved commercial laboratory shall be furnished for all shipments of pipe delivered to the job site.

D. Submittals At Project Closeout

1. Provide a record of the actual location of underground piping and utilities which are concealed from view.
2. Provide operation and maintenance information for valves.

E. See Standard Drawings for additional details.

3.4.2 PRODUCTS

A. Pipe And Fittings

1. General

a. Design pressures: Pressure piping, regardless of type of material, shall be designed for a minimum internal pressure of 150 psi, plus surge pressure and trench loads.

b. Lead content: Any pipe, pipe fitting, solder, or flux used shall be lead free. Lead free is defined by the Safe Drinking Water Act as a weighted average of 0.25% lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and 0.2% lead for solder and flux.

2. Ductile iron pipe (DIP), fittings and accessories:

a. Ductile iron pipe shall be in accordance with ANSI A21.50/AWWA C150 and shall conform to the requirements of ANSI A21.51/ AWWA C151, latest standards. DIP shall be of 60-42-10 ductile iron. All pipe shall be free of cracks or other imperfections. Push-on and restrained joint pipe shall have a minimum rated working pressure (Pressure Class) in accordance with its diameter as indicated in the table below. In no case shall minimum working pressure be less than 150 psi. DIP shall also meet the following requirements:

i For piping having push-on or restrained joints: Provide ductile iron pipe of the minimum pressure class indicated in the table below, unless a thicker wall is required for the depth of bury and bedding as recommended by the pipe manufacturer.

Pipe Sizes (inch)	Pressure Class (psi)
4-12	350
14-20	250
24	200
30-36	150
48	150
60	150

ii Exposed piping having flanged joints shall be Class 53 minimum.

b. Fittings: Use 250 psi pressure rated fittings unless otherwise indicated.

i Mechanical fittings or restrained fittings shall conform to ANSI A21.53/AWWA C153 or ANSI A21.10/ AWWA C110.

ii Flanged fittings shall conform to ANSI A21.10/AWWA C110. The AWWA C110 fitting flanges shall have facing and drilling which match AWWA C115 threaded-on flanges which also match ANSI B16.1 class 125 flanges unless conditions dictate that class 250 flanges are required.

c. Pipe and Fitting Joints:

i Buried piping: Mechanical or push-on type joints complying with ANSI A21.11/ AWWA C111 as modified by ANSI A21.51/ AWWA C151. Joints shall have rubber gaskets and lubricants complying with ANSI A21.11/ AWWA C111.

a) Provide restrained joints in accordance with "Thrust Restraint Design For Ductile Iron Pipe" latest edition, published by the Ductile Iron Pipe Research Association. Joint restraint of the required length shall be provided on each side of fittings and valves and as in other locations along the pipe as required. A minimum safety factor of 1.5 shall be used to calculate the required length of restraint.

ii Buried fittings: Mechanical joints complying with ANSI A21.11/ AWWA C111. The use of pipe manufacturer's approved restrained joints shall also be acceptable for buried fittings.

a) All fitting joints and the required number of pipe joints on each side of fitting shall be restrained. Length of pipe restraint shall be calculated as outlined above.

iii Exposed piping and fittings: Flanged joints shall comply with ANSI A21.15/ AWWA C115.

a) Full face 1/8" thick, rubber ring, factory cut, gaskets shall be used at flanged joints.

b) Bolts and nuts at joint shall conform to ANSI A21.11/AWWA C111.

d. Restrained Joint Pipe and Fittings:

i Provide restrained joint pipe and fittings as outlined in these specifications. Unless approved by the Town, the use of concrete thrust blocking for restraint is not allowed.

ii Provide one of the following restraint methods for restrained piping and fittings:

a) Pipe manufacturer's pipe/fitting restraint by the following pipe manufacturers:

1) American Cast Iron Pipe Company;
2) U.S. Pipe;
3) McWane Ductile

b) External Joint Restraint Mechanism:

1) Mechanical Joints: Restraining mechanisms for mechanical joints shall consist of individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The device shall be capable of full mechanical joint deflection after burial. The joint restraint ring and wedges shall be made of ductile iron conforming to ASTM A536, latest edition. Ductile iron

gripping wedges shall be heat treated within a range of 370 to 470 BHN. Torque limiting twist off nuts shall be used to insure proper actuation of the restraining wedges. Dimensions of the gland shall be such that it can be used with a standard mechanical joint bell conforming to ANSI A21.11/ AWWA C111 and ANSI A21.53/ AWWA C153. The restraint devices shall be provided with a coating for corrosion resistance. Restraining mechanisms for pipe sizes 16-inch and smaller shall have a rated working pressure of 350 psi, while mechanisms for pipe sizes greater than 16-inch shall have a rated working pressure of 250 psi.

2) Push-On Pipe Joints: Restraining mechanisms for push on pipe joints shall consist of a wedge action restraint ring on the pipe spigot joined to a split ductile iron ring behind the pipe bell. The restraint ring shall have individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The restraint ring and its wedging components shall be made of ductile iron conforming to ASTM A536, latest edition. The wedges shall be heat treated to a minimum hardness of 370 BHN. Torque limiting twist off nuts shall be used to insure proper actuation of the restraining wedges. The split ring shall be made of ductile iron conforming to ASTM A536, latest edition. The restraint devices shall be provided with a coating for corrosion resistance. The connecting tie rods that join the two rings shall be made of low alloy steel that conforms to ANSI/AWWA C111/A21.11. The assembly shall have a rated pressure with a minimum two to one safety factor of 350 psi in sizes the 16-inch size and smaller and 250 psi in the 18 through 36-inch sizes.

3) Restraining mechanisms shall be provided with a protective coating meeting the following specifications. All wedge assemblies and related parts shall be processed through a phosphate wash, rinse, and drying operation prior to coating application. The coating shall consist of a minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat. All casting bodies shall be surface pretreated with a phosphate wash, rinse, and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact, and UV resistance.

Acceptable manufacturers for external restraint mechanisms are as follows: 1) EBAA Iron Inc.; 2) Star Pipe Products; 3) Sigma; 4) Town approved equal.

e. Exterior Coatings (Pipe and Fittings):

i Buried piping and fittings shall receive a 1 mil exterior asphaltic coating in accordance with ANSI A21.50.

ii All exposed piping and fittings (excluding piping installed inside of a wet well) shall be furnished with an exterior shop coating of primer in order to facilitate painting. All primed material to receive a field coating as specified under "Painting".

iii All exposed piping and fittings located inside of a wet well shall be coated with an ultra-high build epoxy coating as specified under "Protective Coatings For Precast Concrete Wetwells and Valve Pits".

f. Interior Linings (Pipe and Fittings):

i All ductile iron pipe and fittings shall be lined with Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, and shall meet the following requirements:

a) A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

b) The following requirements from coupon testing:

1) 0.0 undercutting results after a one year period when subjected to ASTM B-117 Salt Spray.
2) Less than 0.5 mm undercutting after 30 days when subjected to ASTM G-95 Cathodic Disbondment 1.5 volts @ 77^{o}F.
3) Immersion Testing rated using ASTM D-714-87 no effect after one year when tested with 20% Sulfuric Acid, 25% Sodium Hydroxide, 160^{o}F Distilled water and 120^{o}F Tap water.

ii Protecto 401 Ceramic Epoxy lining shall be subjected to the application procedure:

a) The lining shall be applied by a competent firm with a successful history of applying linings to the interior of pipe and fittings.

b) Prior to abrasive blasting, the entire area to receive the protective compound shall be cleaned of oil, grease, etc. using a solvent according to the guidelines outlined in DIPRA-1 Solvent Cleaning. Following solvent cleaning, all areas to receive protective coating shall be abrasive blasted using compressed air nozzles with sand or grit abrasive media so that all rust, loose oxides, etc. are removed from the surface.

c) After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry thickness of Protecto 401. No lining shall take place when the substance or ambient temperature is below

40oF. The surface also must be dry and dust free. If flange pipe or fittings are included in the project the lining shall not be used on the face of the flange.

d) Coating of Bell Sockets and Spigot Ends - Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

e) The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely re-coatable with itself without roughening of the surface.

f) Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

g) Lining Inspection:

1) All ductile iron pipe and fittings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness rating.

2) The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

3) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

h) Lining Certification - The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

3. Pipe Accessories

a. Gaskets: Elastomeric gasket joints conforming to the following:

i Gaskets for pipe and fittings shall be a continuous ring of elastomeric material compounded to resist deterioration and of a texture to assure a permanent and watertight seal. Gaskets shall have smooth surfaces, free from pitting, blisters, porosity, or any

other defects. Gaskets shall conform to the requirements of the applicable ANSI, AWWA, and ASTM specifications for the type of pipe specified.

ii Gasket lubricant shall be a water soluble material meeting the requirements of ANSI/NSF 61 as well as the requirements of the pipe manufacturer. Lubricant shall be suitable for use in hot or cold weather and shall adhere to wet or dry pipe. It shall be delivered to the jobsite in unopened containers bearing the manufacturer's name and the trade name of the product.

b. Trace Wire:

i Provide tracing wire on all buried piping.

ii Trace wire shall be a 12-gauge green insulated copper wire.

iii Install in trench along the pipe. Splice trace wire in accordance with manufacturers recommendations.

iv Provide trace wire access box in accordance with the detail provided in the Standard Drawings. Access box spacing to be approved by the Town.

c. Metallic Detection Tape:

i Provide 2" wide metallic, detectable detection tape on all buried piping. Provide with plastic covering imprinted with "Caution Buried Sewer Line Below" or similar approved message in large letters on both sides.

a) Provide 5.0 mil overall thickness with no less than a 50 gauge solid aluminum foil core.

b) Foil to be visible from both sides.

c) No inks or printing extended to the edges of the tape.

d) Encase printing to avoid ink rub-off.

e) Tensile strength - 28 Ibs/inch.

f) Use heat set mylar inks.

ii Locate 12" below ground surface in pipe trench.

iii Color to be safety green.

B. Plug Valves

1. General:

a. Provide non-lubricated, eccentric type plug valves having resilient faced plugs, complying with AWWA Standard C517 and other requirements specified herein.

b. Furnish flanged or mechanical joint end connections as indicated on the Standard Drawings. Flanged valves shall be faced and drilled to ANSI 125/150 lb. standards. Mechanical joint ends shall conform to AWWA Standard C111.

c. Provide valves of bolted bonnet design:

i Valves 4" and larger to be designed to allow repacking without removing the bonnet and the packing shall be adjustable.

ii Packing to be replaceable with the valve under pressure with valve open or closed with pressure on either side of the plug.

d. Provide valves capable of drip-tight shutoff up to full rating with pressure in either direction. Pressure ratings shall be 175 psi for 4" through 12", 150 psi for 14" through 36", and 125 psi for 42" and larger.

e. Valve bodies shall be cast iron complying with ASTM A126, Class B and AWWA Standard C517.

f. Plug shall be constructed of ASTM A126 Class B cast iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft.

g. All exposed nuts, bolts, springs, etc. shall be stainless steel on all valves.

2. Port Areas

a. Four inch through twenty inch valves, not less than 80% of full pipe area.

b. Twenty-four inch and larger, not less than 70% of full pipe area.

i Port to be smoothly shaped with an unobstructed waterway when open.

3. Seats

a. Provide corrosion resistant seats complying with AWWA Standard C517.

b. Three inch and larger valves to have a 1/8" thick welded-in overlay of not less than 90% nickel content on all surfaces contacting the plug face.

i Seat to be raised from the valve body and machined to a smooth finish.

4. Bearings

a. Provide valves through twenty inch size with permanently lubricated, 316 stainless steel bearings in the upper and lower plug stem journals.

b. Provide twenty-four inch and larger valves with bronze bearings and stainless steel sleeves in the upper and lower plug stem journals.

c. Lower bearing housing to be raised from the body to reduce the possibility of grit and sand entering the bearing housing.

5. Flanged End Connections

a. Provide, where indicated, valves with flanged ends, faced and drilled to ANSI 125/150 pound standard.

b. Flanged valves through 12" to have face-to-face dimensions of AWWA standard gate valves.

6. Resilient Plug Facing

a. Provide neoprene or Buna-N plug facings vulcanized to the plug and suitable for use with domestic wastewater.

b. Plug to be one piece.

c. Do not use plugs with cast inlays.

7. Buried Service Valves

a. Provide seals on all shafts and gaskets on valve covers to prevent entry of water and dirt.

8. Actuators

a. Manual valves to be provided with lever, handwheel or gear actuators and tee wrenches, as indicated on the Standard Drawings.

i Provide a lever or handwheel for each lever or handwheel operated valve. Handwheel shall be a minimum 12-inches in diameter.

ii Valves furnished for installation in a valve box to be provided with a 2" square operating nut and extension within 18" of the top of the valve box.

iii Provide 6" and larger valves with gear actuators.

a) Provide gear to fit on hexagonal valve shaft to allow operation without the use of roll pins.

b) Handwheel components between the input and the stop-limiting devices to be designed to withstand, without damage, a pull of 200 pounds.

c) Gear actuators, normal service:

1) Enclose all gearing in a cast iron housing suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt or water into the actuator.

2) Support actuator shaft and quadrant on permanently lubricated bronze bearings.

3) Provide valve position indicator and an adjustable stop to set closing torque.

4) All exposed nuts, bolts and washers to be stainless steel.

5) Provide air gap between the actuator and the valve body to prevent leakage from the valve into the actuator.

d) Gear actuators, buried service:

1) Provide neoprene seals on all shafts and gaskets on actuator covers to prevent entry of water and dirt.

2) Mounting brackets to be totally enclosed with gasket seals.

3) Support actuator shaft and quadrant on permanently lubricated bronze bearings.

4) All exposed nuts, bolts and washers to be stainless steel.

C. Check Valves

1. Cushioned swing check valves, 3" and larger:

a. Valves 3" diameter and larger shall have cast iron body with bronze seating ring and stainless steel shaft for attachment of lever and spring with non-adjustable air cushioned shock chamber.

b. The cushioned chamber shall be mounted to the side of the valve body with piston operating in the chamber which will allow valve closing without hammering action.

c. Shock absorption shall be by air with adjustable closing speed.

D. Combination Air and Vacuum Valves

1. Type 1: Single Body Combination Air Valve

a. Provide universal type, single body, cast iron, float operated combination air and vacuum valve to seal both the pressure orifice and the air and vacuum orifice simultaneously. The internal linkage and float shall be stainless steel.

b. Valve shall be suitable for sewage service at a working pressure of 150 psi and capable of exhausting large amounts of air during filling, exhausting small amounts of accumulated air during operation, and admitting large amounts of air upon impending vacuum during draining.

c. Provide a valve with minimum 2-inch inlet and 2-inch outlet.

d. Orifice size shall be as required for operating flow and pressure.

e. Valve shall be provided with flushing attachments consisting of an inlet isolating valve, bronze blow-off and flushing valve, and a minimum of 5 feet of rubber hose with quick disconnects.

2. Type 2: Short Body Combination Air Valve

a. Provide short body type combination air valve consisting of two independent valves: a large orifice air and vacuum valve and a small orifice air release valve piped together into a single assembly with a single connection to the force main. The assembly shall be complete with shutoff valves to allow each valve to be isolated from the line.

b. Valve shall be suitable for sewage service at a working pressure of 150 psi and capable of exhausting large amounts of air during filling, exhausting small amounts of accumulated air during operation, and admitting large amounts of air upon impending vacuum during draining.

c. Provide a valve with minimum 2-inch inlet and 2-inch outlet.

d. Maximum height for 2-inch x 2-inch assembly shall be 17-¼".

e. Orifice size shall be as required for operating flow and pressure.

f. All internal metal trim components shall be stainless steel.

g. Valve shall be provided with flushing attachments consisting of an inlet isolating valve, bronze blow-off and flushing valve, and a minimum of 5 feet of rubber hose with quick disconnects.

E. Stainless Steel Ball Valves

1. Valves shall have a three-piece swing-out design.
2. Valves shall have an adjustable three-piece stem packing.
3. Provide blowout-proof stems on valves.
4. Valve seats are to be supported by a small stainless steel coned disc spring which provides a positive sealing force at high and low pressures.
   a. Seats are to automatically compensate for wear and thermal expansion.
5. Seal flanges to center body section with O-rings which are fully contained and seal independently of the ball seat.
6. Provide stem which rides on a Vespel thrust washer allowing lower operating torques and longer life.
7. Materials of construction:

Body, ball, stem, gland	316 SS
Flanges	316 SS
Stem packing, ball seats	TFE
Deformable glands	Ceramic filled TFE
Stem thrust washer	Vespel
Coned disc springs	316 SS
Grounding spring	316 SS
Flanged seals	Viton O-rings
All bolts and nuts	316 SS
Stop plate	316 SS
Nameplate	302 SS
Handle grip	Vinyl

F. Valve Boxes

1. Each valve buried in the ground shall be provided with a valve box and cover. The boxes shall be adjustable slip on type made of close-grained gray cast iron, in three pieces, comprising of the lower base piece which shall fit around the stuffing box gland and rest on the valve bonnet, the upper part which shall slide onto the lower part and have a socket to receive the cover. The cover shall have the word "SEWER" cast on the upper surface in raised letters. All castings shall be thoroughly cleaned and heavily coated with asphalt or coal-tar varnish.
2. Each valve box shall be fitted with an extension stem for use with the buried service non-rising stem valves. The stem shall be of metal and used to extend the position of the 2" operating nut to within 18 inches of grade. Each stem shall be fitted with a self-centering disk below the operating nut to keep the stem aligned in the valve box and minimize the amount of grit that can enter the valve box.

G. Freezeless Yard Hydrant:

1. Provide Woodford (Iowa) Model Y1 freezeless yard hydrant, or approved equal.
2. Inlet shall be 1" NPT.
3. Provide ¾" NPT brass nozzle outlet with vacuum breaker.
4. Provide 1-inch curb stop with extension curb box.

H. Link Seal Sleeve Seal

1. Provide sleeve seals where indicated on the Standard Drawings and as required to seal between pipe sleeves and piping.
2. Provide reinforced nylon polymer pressure plates.
3. Provide 316 stainless steel bolts and nuts.
4. Provide EPDM sealing element.
5. Acceptable manufacturer is Link Seal - Model S or approved equal.

3.4.3 EXECUTION

A. Handling, Inspection, And Storage

1. Handle pipe and pipe accessories so as to ensure delivery to the point of installation in sound, undamaged condition. Do not drag pipe into position. Use caution not to damage pipe linings and coatings.
2. Thoroughly clean interior of pipe and accessories before installation. Keep clean during installation by plugging or other method approved by the Town.
3. Before installation, inspect each piece of pipe and each fitting for defects:
   a. Material found to be defective before or after installation: Replace with sound material meeting the specified requirements, and without additional cost to the Owner.
4. Rubber gaskets: Store in a cool dark place until just prior to time of installation.

B. Pipe Cutting

1. Cut pipe neatly, without damage to the pipe and in accordance with pipe manufacturer's recommendations.

C. Pipe Installation - General

1. General:
   a. See Standard Drawings for pipe bedding, backfilling and compaction requirements.
   b. Lower pipe and accessories into trench by means of derrick, ropes, belt slings, or other equipment.
   c. Do not dump or drop any of the materials of this Section into the trench.

d. Rest the full length of each section of pipe solidly on the pipe bed, with recesses excavated to accommodate bells, couplings, and joints.

e. Remove and re-install pipe that has the grade or joint disturbed after original installation.

f. Do not install pipe in water, or when trench conditions are unsuitable for the work; keep trench free of water until jointing is completed.

g. Securely close open ends of pipe, fittings, and valves when work is not in progress.

h. Where any part of pipe coating or lining is damaged, it shall be repaired to the approval of the Town.

i. Pipe deflection shall not exceed the pipe manufacturer's maximum recommended deflection. If deflection in excess of the maximum recommended deflection is required for alignment, the required fittings shall be provided to ensure that deflection is within the acceptable limit.

j. Provide a minimum of 48-inches of cover over pipe, except in areas where less cover is indicated on the Standard Drawings.

k. Install tracing wire and metallic detection tape in accordance with the detail provided in the Standard Drawings.

2. Ductile iron pipe:

a. Ductile iron piping and accessories shall be installed in accordance with ANSI/AWWA C600.

i Gaskets: Handle, lubricate where necessary and install in strict accordance with manufacturer's recommendations,

b. Flanged joints:

i Provide true face flanges, field clean and fit with one full face gasket and install bolts finger tight.

ii Use torque wrench to alternately tighten bolts 180 degrees apart until full gasket flow and seal are secured.

D. Setting Valve Boxes

1. Center valve boxes on the valves, setting plumb.

2. Tamp earth fill around each valve box to a distance of four feet on all aides, or to the undisturbed trench face if less than four feet.

3. Provide protective concrete ring around top of valve boxes as indicated on the Standard Drawings.

4. Valve stem extensions shall be provided to bring the valve operating nut to within at least 18" of finished grade, if required.

E. Backflow Preventer

1. Provide a backflow preventer on potable water service lines of the type/model required by the Town and approved by SCDHEC. Install

valves in strict accordance with the manufacturer's recommendations and as approved by the Town and SCDHEC.

2. Testing:

a. Each backflow prevention device shall be tested by an individual certified by SCDHEC.

b. Tester shall complete a SCDHEC test form and submit to the Town.

F. Pressure Testing Of Pipes

1. All piping shall be pressure tested using the method and test pressure indicated in herein.

2. General:

a. The line to be tested shall be cleaned and flushed to remove dirt or other debris.

b. Notify Town at least 48 hours prior to any testing.

3. Hydrostatic Testing - Pressure Lines

a. Pressure tests shall be performed on all completed lines in accordance with AWWA C600, latest edition.

b. The line segments to be tested shall be slowly filled with water and all air shall be completely expelled from the line being tested before the test pressure is applied.

c. The specified test pressures shall be determined in accordance with AWWA C600 and approved by the Town.

d. The specified test pressure shall be maintained for not less than two hours or as long as the Town may require in order to detect any leakage or defective material. Any makeup water required shall be carefully measured and the leakage shall not exceed the requirements of AWWA C600. Any visible leakage shall be corrected. A 4½ inch diameter oil filled 0 - 200 PSIG test gage shall be used to indicate the test pressure.

e. Leakage is defined as the quantity of water that must be injected into the pipeline or section of pipeline in order to maintain the required test pressure after all air has been purged form the pipe and the pipe has been completely filled with water. The piping will not be accepted until leakage is less than the number calculated using the formula provided in AWWA C600. If leakage exceeds the calculated value, the defective joint or joints shall be located and repaired.

3.5 NON-SHRINK GROUT

3.5.1 GENERAL

A. Section Includes: Non-shrink grout for equipment bases, etc. as indicated and needed for a complete and proper installation.

B. Submittals For Review

1. Materials list of items proposed to be provided under this Section
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

3.5.2 PRODUCTS

A. Non-shrink grout:

1. Provide non-metallic, non-shrink grout meeting the requirements of ASTM C827, ASTM C1107 and U.S. Army Corps of Engineers Specifications CRD C 621.
2. Grout shall evidence no shrinkage when tested in the plastic state, in accordance with ASTM C827, or in the hardened state, in accordance with Corps of Engineers Specification CRD C 621,
3. Initial setting shall not occur in less than 60 minutes.
4. Compressive strength in 24 hours shall not be less than 3000 psi, when tested in accordance with ASTM C109.
5. Acceptable products: Five Star Products Five Star Grout; Sonneborn's Sonogrout; Bonsal American Non-Shrink Grout; or equal.

B. Water: Potable grade.

C. Gravel: Comply with ASTM C33 for coarse aggregate graded so that 90% passes 3/8" sieve and 90% is retained by No. 4 sieve.

D. Mixes

1. Less than 2" clearance or for difficult grouting locations mix shall consist of grout material and water.
2. Greater than 2" clearance where coarse aggregate will not obstruct free passage, extend grout by adding 1/2 pound of gravel to one pound grout material, except where prohibited by manufacturer's recommendations.
3. Use the minimum amount of water necessary to produce a flowable grout without causing segregation or bleeding.

E. Mixing

1. Mix non-shrink grouting material and water in a mechanical mixer for no less than 3 minutes.
2. Mix as close to work area as possible and transport the mixture quickly and in a manner that does not permit segregation of materials,
3. Re-tempering of grout will not be permitted.

3.5.3 EXECUTION

A. Formwork

1. Build leakproof forms that are strong and securely anchored and shored to withstand grout pressures.
2. Provide ample clearance between formwork and the area to be grouted to permit proper placement of grout.

B. Surface Preparation

1. Remove all defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by bush-hammering, chipping, or other similar means, until a sound, clean concrete surface is achieved.
2. Lightly roughen the concrete, but not enough to interfere with the proper placement of grout.
3. Remove foreign materials from all steel surfaces in contact with grout.
4. Align, level and maintain final positioning of all components to be grouted.
5. Take special precautions during extreme weather conditions according to the manufacturer's written instructions.
6. Saturate all concrete surfaces with clean water; remove excess water and leave none standing.

C. Placing

1. Place non-shrink material quickly and continuously by the most practical means permissible: pouring, pumping or under gravity pressure.
2. Apply grout from one side only to avoid entrapping air.
3. Final installation shall be thoroughly compacted and free from air pockets.
4. Do not vibrate the placed grout mixture, or allow it to be placed if the area is being vibrated by nearby equipment.
5. Do not remove leveling shims for at least 48 hours after grout has been placed.
6. After shims have been removed, fill voids with plain cement-sand grout.

D. Curing

1. Cure grout for 3 days after placing by keeping wet and covering with curing paper or by another approved method.

3.6 MISCELLANEOUS METALS

3.6.1 GENERAL

A. Section Includes: All miscellaneous metal work, as indicated, specified, or as needed to provide a complete and proper installation.

B. References:

1. AISC - Code of Standard Practice.
2. ASTM A36/A36M - Standard Specification For Carbon Structural Steel.
3. ASTM A53 – Standard Specification For Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
5. ASTM A123 – Standard Specification For Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.
6. ASTM A153 – Standard Specification For Zinc Coating (Hot Dip) on Iron and Steel Hardware.
7. ASTM A242/A242M - Standard Specification For High-Strength Low-Alloy Structural Steel.
8. ASTM A307 - Standard Specification For Carbon Steel Bolts, Studs and Threaded Rod 60,000 PSI Tensile Strength.
9. ASTM F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions ASTM A449 - Quenched and Tempered Steel Bolts and Studs.
10. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
11. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. ASTM A502 - Standard Specification for Rivets, Steel, Structural
13. ASTM A514/A514M - Standard Specification for High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
14. ASTM A529/A529M - Structural Steel With 42 KSI (290 MPa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness).
15. ASTM A563 – Standard Specification For Carbon and Alloy Steel Nuts.
16. ASTM A568/A568M - General Requirements for Steel, Sheet, Carbon, Structural and High-Strength Low-Alloy Hot-Rolled and Cold-Rolled.
17. ASTM A572/A572M – Standard Specification For High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
18. ANSI/AWS A2.4 – Standard Symbols for Welding, Brazing, and Nondestructive Examination.
19. AWS D1.1 - Structural Welding Code.

20. FM - Roof Assembly Classifications.
21. SSPC (Steel Structures Painting Council) - Painting Manual.
22. UL - Fire Resistance Directory.
23. Warnock Hersey - Certification Listings.

C. Submittals for Review:

1. Materials list of items proposed to be provided under this Section.
    a. Provide a listing of all items to be provided and include the type and location.
    b. Manufacturer's specifications and other data needed to demonstrate compliance with the specified requirements.
    c. Shop drawings shall show the size of components, materials of construction, connection to other components and anchorage.
    d. Samples shall be submitted at the Town's request.

D. Submittals for Information:

1. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent work.

E. Product Handling:

1. All aluminum pipe and elbows shall be packed and shipped in individual plastic film to protect the anodized finish.
2. All aluminum pipe and elbows shall be stored out of contact with ground and concrete.

3.6.2 PRODUCTS

A. General

1. Finished and machined faces shall be true to line and level.
2. Welding shall conform to applicable requirements of:
    a. Steel products: American Welding Society Standard D1.1.
    b. Aluminum alloy products: Recommended practices as published in "Welding Aluminum" by the American Welding Society.
3. Unless otherwise specified, materials shall conform to the following:

Structural Steel	See Structural Drawings
Welded and Seamless Steel Pipe	ASTM A53
Steel Tubing	ASTM A501
Gray Iron Castings	ASTM A48, Class 30
Galvanizing, General	ASTM A123
Galvanizing, Hardware	ASTM A153
Aluminum (Extruded Shapes)	6063 T5 (Alum alloy)
Aluminum (Extruded Pipe)	6063 T6 (Aluminum alloy) or 6105 T6 (Aluminum alloy)

Aluminum Bars and Shapes (Structural)	6061 T6 (Alum alloy)
Bolts and Nuts	ASTM A307
Stainless Steel Bolts, Fasteners	AISI Type 304
Stainless Steel Plate and Sheet, Wire	AISI Type 316
Welding Rods for Steel	AWS Spec. for Arc Welding

B. Workmanship and finish shall be equal to the best practices of modern shops for the respective work.

1. Exposed surfaces shall have a smooth finish and sharp, well defined lines.
2. Sections shall be well formed to shape and size with sharp lines and angles.
3. Curved work shall be sprung evenly to curves.
4. Metal work shall be countersunk properly to receive hardware and provided with the proper bevels and clearance.
5. Cutting shall be done by shearing, sawing or flame cutting; if flame cut, the metal shall be ground back to smooth sound material.
6. Holes for bolts and screws shall be drilled.
7. Conceal fastenings where practicable.

C. Steel And Iron Shapes

1. Provide standard, well finished, structural shapes of commercial grade bar stock.
   a. Rolled shapes shall conform to dimensions and weights of Regular Series Shapes of AISC.

D. Aluminum Shapes

1. Provide extruded shapes of 6063-T5 alloy unless another alloy is better suited for the intended purpose.
2. Furnish structural shapes conforming to dimensions and weights of the standard structural shapes of the Aluminum Association of 6061-T6.

E. Anchor Bolts And Miscellaneous Fastenings

1. General:
   a. Provide as indicated, or as necessary for securing work in place, and anchoring equipment in place.

F. Provide anchor bolts, expansion anchors, epoxy adhesive anchors, nuts, washers and other fasteners of the materials indicated below unless otherwise indicated on the drawings.

1. Fastening structural steel shapes and plates to each other - ASTM A325 bolts.
2. Anchoring structural steel to concrete - ASTM A307 anchor bolts.
3. Fastening or anchoring stainless steel or aluminum to any material - Type 316 stainless steel.

4. Anchoring process or mechanical equipment regardless of material to concrete - Type 316 stainless steel.
5. Anchoring or fastening any materials which will be submerged in water or wastewater - Type 316 stainless steel.
6. Any anchors or fasteners in contact with potable water - stainless steel.
7. Anchoring wood or timber in non-submerged application - hot dipped galvanized.
8. Other fasteners and anchor bolts not otherwise specified - Type 316 stainless steel

G. Expansion anchors:

1. Use stud type with one piece wrap around expansion sleeve.
2. Provide complete unit manufactured from 316 series stainless steel.
3. Acceptable products: Phillips "wedge-Anchors", Ramset "Trubolt Stud Anchors"; or Hilti "Kwik-Bolt".
4. Do not use expansion anchors in masonry.

H. Epoxy adhesive anchors:

1. Provide injected epoxy adhesive anchors, consisting of screen tube and anchor rod.
2. Anchor rod and nut to be Series 316 stainless steel.
3. Acceptable products: Hilti “HIT" or equal.
4. Use in masonry and where otherwise indicated.

I. Inserts And Sleeves

1. Provide as required and needed for support of piping, equipment and apparatus, or where passages through walls, floors, etc. are required.
2. Bite and material shall be as indicated, or as approved by the Engineer.

J. Unistrut Channels

1. Channels shall be accurately and carefully extruded to size from aluminum, except as noted otherwise.
2. Channels shall be Type 304 stainless steel.
3. Provide a continuous slot with in-turned clamping ridges on one side of channel.
4. Fittings to be stainless steel or aluminum.
5. Minimum size for channels shall be 1-5/8" x 1-5/8" x .105" thick.
6. Provide end caps on channels.
7. Nuts, pipe hangers, clamps, etc. shall be units specifically intended and manufactured for use with "Unistrut” channels.
8. All nuts, bolts, caps and clamps shall be stainless steel.
9. Provide flexible elastomer material, "Uni-cushion" or equal, between all pipe clamps or hangers and PVC, copper or stainless steel pipe.

K. Access Rungs/Manhole Steps

1. Use aluminum steps.
2. Provide steps having non-skid top surfaces, safety slope at each end, minimum width of 10" and not less than 5" projection from wall.
3. Aluminum steps shall support 1000 pound load at center with no deformation, coat embedded ends with bituminous paint.

L. Floor Access Doors And Hatches

a. Unless otherwise specified on the Standard Drawings or elsewhere in these specifications, access Doors and Hatches shall meet the following minimum requirements.

b. Provide ¼" thick, one-piece, mill finish, extruded aluminum frame, incorporating a continuous concrete anchor.

c. Furnish ¼" thick aluminum diamond plate door leaf(s), reinforced to withstand a live load of 300 pounds per square foot.

d. Door(s) shall open to 90° and automatically lock with stainless steel hold open arms with aluminum release handles.

e. All hardware including hinges and fastening hardware shall be stainless steel.

f. Unit shall have a snap lock, flush with top surface, having removable handle.

g. Provide 1½" drainage coupling in channel frame.

h. Standard mill finish shall be provided on all aluminum surfaces, except for frames to be embedded in concrete. Frames to be embedded in concrete shall have a bituminous coating factory applied to the exterior of all frame surfaces that may come into contact with concrete.

i. Size and type of access door shall be as indicated on the Drawings.

j. Acceptable manufacturers: U.S.F. Fabrication, Inc., Hialeah, Florida; Halliday Products, Inc., Orlando Florida; or equal products by other manufacturers.

3.6.3 EXECUTION

A. General

1. Install all items, plumb, square and level as intended and as shown on the Drawings.

B. Masonry Anchors

1. Drill hole in accordance with manufacturer's guidelines.
2. Inject epoxy using manufacturer's approved injection equipment.
3. Allow three hours cure time before putting a load on the anchors.
4. Do not install if temperature is to be below 40 degrees F during time required for cure.

C. Unistrut Channels

1. Mount on wall, floor or ceiling using stainless steel expansion or masonry anchors or embed in concrete where indicated.
2. Install channels level and plumb.
3. Fabricate from "Unistrut" channel sections and fittings as indicated.
4. Make all cuts square and free from burrs.

D. Access Rungs

1. Cast in walls of pits, manholes, etc. as the wall is placed.

E. Floor Doors And Hatches

1. Set level, top flush with finish slab elevation, orient door opening as indicated, or as approved by the Town.
2. Protect surface from concrete splatters during placement of concrete.
3. Clean surface of any concrete stains, etc.

3.7 PROTECTIVE COATINGS FOR CONCRETE WETWELLS AND VALVE PITS

3.7.1 GENERAL

A. Section Includes: All materials, and equipment required for substrate protection against corrosion as a result of applying a protective epoxy coating to new concrete substrates. Protective coatings shall be used in the locations/structures noted on the Standard Drawings.

B. References

1. ASTM D638 - Tensile Properties of Plastics.
2. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
3. ASTM D695 - Compressive Properties of Rigid Plastics.
4. ASTM D1042 – Linear Dimension Changes of Plastics Under Accelerated Service Conditions.
5. ASTM D2196 – Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield Type) Viscometer.
6. ASTM D2396B – Volatile Content Testing.
7. ASTM D3974-95 – Flexible Cellular Materials.
8. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.
9. ASTM D2584 - Volatile Matter Content.
10. ASTM D2240 - Durometer Hardness, Type D.
11. ASTM D543 - Resistance of Plastics to Chemical Reagents.
12. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
13. ASTM C321 – Bond Strength.
14. ASTM C596 – Dry Shrinkage of Mortar Containing Hydraulic Cement.
15. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
16. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
17. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
18. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
19. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.

C. Submittals For Review

1. Product data: Submit the following:
    a. Materials list of items proposed to be provided under this Section;

b. Manufacturer's specifications, technical and safety sheets and other data needed to demonstrate compliance with the specified requirements.

D. Applicator qualifications.

1. Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.

2. Certification that the equipment to be used for applying the products has been manufactured or approved by the protective coating manufacturer and Applicator personnel have been trained and certified for proper use of the equipment.

E. Quality Assurance

1. Reference manufacturer for lining is Raven Lining Systems, Inc., Tulsa, Oklahoma which is named to establish a standard of quality.

2. Reference manufacturer for rehabilitation products (where required) is Quadex, Inc. Sewer Rehabilitation Products, Little Rock, Arkansas.

3. All work shall be performed by personnel licensed and certified as technically trained by the manufacturer of the products to be used.

4. A NACE III Certified Coating Inspector shall inspect and verify that the epoxy liner is installed according to specifications, manufacturer recommendations, and industry standards. The inspector shall submit a final report documenting field observations and testing results.

F. Product Handling

1. Deliver all material to site in original, new, unopened containers, labeled and bearing manufacturer's name and stock number, product and brand name, contents by volume for major constituents, instructions for mixing and reducing, and application instruction.

2. Store products in accordance with manufacturer’s recommendations.

3.7.2 PRODUCTS

A. Schedule: Apply protective concrete coatings as specified herein and as shown on the Standard Drawings.

B. Structure:

1. 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 cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred.

2. Cementitious patching and repair materials should not be used unless their manufacturer provides information as to their suitability and procedures for top-coating with an epoxy coating. Information provided shall include application, cure time and surface preparation procedures which permit optimum bond strength with epoxy coating.

3. Applicator shall maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation.

C. Protective Coating Material:

1. Ultra high build epoxy coating system: 100% solids, solvent-free two-component epoxy resin system thixotropic in nature, with fillers to minimize permeability and provide sag resistance acceptable to these specifications. The epoxy must be moisture tolerant for damp applications, and capable of curing in the presence of water. The protective coating system shall be able to be applied to damp, concrete surfaces exhibiting a moisture vapor emission rate greater than 5 lbs./1,000 ft^2 per 24 hours.

2. Product type: Amine cured epoxy

Color:	Light Blue
Solids Content (vol %):	100
Mix Ratio:	3:1 ratio
Compressive Strength:	12,870 PSI
Tensile Strength, (PSI):	6,640 PSI
Tensile Elongation (%):	1.53 %
Flexural Modulus, (PSI):	12,443 PSI
Hardness, Type D:	80
Bond Strength (Concrete):	>Tensile Strength of Concrete

D. Repair Mortar Spray Application Equipment:

1. Spray applied repair mortars shall be applied with manufacturer approved equipment.

E. Protective Coating Application Equipment:

1. Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective coating.

3.7.3 EXECUTION

A. Applicators

1. Repair mortar must be applied by manufacturer trained and approved applicators. The cementitious mortar shall be applied according to manufacturer's recommendations.

2. Protective coating must be applied by a certified applicator of the protective coating manufacturer and according to manufacturer specifications.

B. Examination

1. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.

2. Any active flows shall be dammed, plugged or diverted as required to ensure that the liquid flow is maintained below the surfaces to be coated.

3. Installation of the protective coating shall not commence until the concrete substrate has properly cured in accordance with these specifications.

4. Temperature of the surface to be coated must be maintained between 40 degrees F and 120 degrees F during application. Prior to and during application, care should be taken to avoid exposure to direct sunlight or other intense heat sources in proximity to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising.

C. Surface Preparation

1. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation.
2. All contaminants including: oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.
3. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.
4. Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the epoxy protective coating to be applied.
5. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. At a minimum, this will be achieved with a high pressure water cleaning equipment using a 0 degree rotating nozzle at 5,000 PSI and 4 GPM. Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying and/or acid etching may also be used. In addition, detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. The method(s) used shall be performed in a manner that provides a uniform, sound clean, neutralized surface that is not excessively damaged.
6. Any infiltration present shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for topcoating with the specified epoxy protective coating.
7. 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.

D. Application Of Repair Materials

1. Repair materials shall meet the specifications herein. The materials shall be trowel or spray applied utilizing proper equipment on to specified surfaces.
2. If using approved cementitious repair materials, such 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.

3. The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds should not be used unless approved for compatibility with the specified protective coating.

4. Application of the repair materials, if not performed by the coating certified applicator, should be inspected by the protective coating certified applicator to ensure proper finishing for suitability to receive the specified coating.

5. After abrasive blast and leak repair is 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.

E. Application Of Protective Coating

1. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.

2. 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.

3. The protective coating material must be spray applied by a certified applicator of the protective coating manufacturer.

4. Specified surfaces shall be coated by spray application of the moisture tolerant, solvent-free, 100% solids, epoxy protective coating described herein. Spray application shall be to an average dry film thicknesses of 125 mils (1^{st} Coat 62.5 mils, 2^{nd} Coat 62.5 mils) on new structures.

F. 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.

1. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

3.7.4 TESTING AND INSPECTION

A. During application a wet film thickness gage 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.

B. After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied. All detected holidays shall be marked and repaired by abrading the coating surface with grit

disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

C. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures specified herein.

3.8 PAINTING

3.8.1 GENERAL

A. Section Includes: Preparation, painting and finishing the exterior and interior surfaces indicated or specified, and as needed for a complete and proper installation.

1. Surfaces not specifically excluded shall be painted, whether new or existing.

B. Unless otherwise indicated, painting of following surfaces will not be required.

1. Concealed areas and inaccessible areas such as furred spaces, foundation spaces, utility tunnels, pipe spaces, and duct shafts. Concealed ferrous metal surfaces shall be painted.
2. Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper (except piping), bronze and similar non-ferrous materials.
3. Moving parts of operating units, mechanical or electrical parts such as valve operators, linkages, sensing devices, and motor shafts.
4. Exterior concrete surfaces.
5. PVC piping systems.
6. Instruments, control panels, and other equipment having factory applied finishes.
7. Do not paint over required labels or equipment identification, performance rating, name, or nomenclature plates.

C. References:

1. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
2. NACE (National Association of Corrosion Engineers) - Industrial Maintenance Painting.
3. ACA (American Coatings Association) - Guide to U.S. Government Paint Specifications.
4. PDCA (Painting and Decorating Contractors of America) - Painting - Architectural Specifications Manual.

D. Definitions:

1. "Paint", as used herein, means coating systems materials including primers, emulsions, epoxy, enamels, sealers, fillers and other applied materials whether used as prime, intermediate or finish coats.

E. Paint coordination:

1. Provide finish coats which are compatible with the prime coats actually used.
2. Review other Sections of these Specifications as required, verifying the prime coats to be used and assuring compatibility of the total coating system for the various substrata.

3. Provide barrier coats over noncompatable primers, or remove the primer and reprime as required.

3.8.2 PRODUCTS

A. Paint Materials

1. All paint materials to be used in any one system shall be the products of one manufacturer.
2. Use only the thinners recommended by the paint manufacturer, and use only to the recommended lImits.

B. Application Equipment

1. Use only such equipment as is recommended by the paint manufacturer.

3.8.3 EXECUTION

A. Surface Conditions

1. Examine all areas to be painted. Correct conditions detrimental to timely and proper completion of the work.

B. Environmental Conditions

1. Environmental conditions shall be within manufacturers guidelines during application of paint.

C. Surface Preparation

1. General:
   a. Prepare and clean all surfaces to be painted with the objective of obtaining a smooth, clean and dry surface.
   b. Surfaces to be painted shall be free from cracks, ridges, nail holes, etc.
   c. Surfaces to be painted shall be free of oil, grease, dirt, dust, rust, scale, etc.
   d. Schedule cleaning and painting so that dust and other contaminants from cleaning operations will not fall onto newly painted surfaces.
2. Ferrous metals:
   a. Remove all rust, dust, scale and other foreign substances.
   b. Give welded joints special attention, removing all welding flux, slag and weld spatter.
3. Non-ferrous metals:
   a. Solvent clean prior to shop or field application of pretreatment and/or primer.
4. Factory finished components:
   a. Solvent clean prior to field application of pretreatment and/or primer.

D. Materials Preparation

1. General:
   a. Mix and prepare paint materials in strict accordance with the manufacturer's recommendations.

E. Paint Application

1. General:

   a. Touch-up shop applied prime coats which have been damaged, and touch-up bare areas prior to start of finish coats.

   b. Slightly vary the color of succeeding coats.

   c. Sand and dust between coats to remove defects visible to the unaided eye from a distance of five feet.

   d. On removable panels and hinged panels, paint the back sides to match the exposed sides.

   e. Items with factory finishes shall be field painted to the color chosen by the Town per the requirements contained herein.

2. Drying:

   a. Allow sufficient drying time between coats, modifying the period as recommended by the material manufacturer to suit adverse weather conditions.

3. Brush or roller applications:

   a. Brush or roll coats onto the surface in an even film.

   b. Cloudiness, spotting, holidays, laps, brush or roller marks, runs, sags, ropiness and other surface imperfections will not be acceptable.

4. Spray application:

   a. Employ spray application on all metal surfaces, equipment, pipe, valves, and similar surfaces where hand work would be inferior.

   b. Where spray application is used apply each coat to the specified dry film thickness.

   c. Do not double back with spray equipment to build up film thickness of two coats in one pass.

F. Painting Schedule

1. Provide one prime coat (shop or field) and two finish coats, unless otherwise specified, in accordance with the following:

2. Ferrous metal submerged in wastewater and non-potable water:

   a. System: High Solids Epoxy

   b. Surface preparation: SSPC-SP10 Near-White Blast Cleaning

   c. Shop coat: Modified Aromatic Polyurethane Primer (Tnemec Series 1 Omnithane Primer, 3.0 dry mils, or equivalent by Sherwin Williams)

   d. 2nd coat: Polyamide Epoxy (Tnemec Series 66 Hi-Build Epoxoline, 4.0 dry mils, or equivalent by Sherwin Williams)

   e. 3rd coat: Cycloaliphatic Amine Epoxy (Tnemec Series 104 H.S. Epoxy, 8.0 dry mils, or equivalent by Sherwin Williams)

   f. Type finish: Semi-gloss

3. Ferrous metal, including C.I. or D.I. pipe, non-immersion:

a. System: High Build Urethane

b. Surface preparation: SSPC-SP6 Commercial Blast Cleaning (fabrications) or SSPC-SP3 Power Tool Cleaning

c. Shop coat: Manufacturer Standard Primer, 2:0 dry mils

d. 2nd coat: Moisture Cured Aromatic Urethane (Tnemec Series 530 Omnithane, 3.0 dry mils, or equivalent by Sherwin Williams)

e. 3rd coat: Aliphatic Acrylic Polyurethane (Tnemec Series 73 Endura-Shield III, 4.0 dry mils, or equivalent by Sherwin Williams)

f. Type finish: Semi-gloss

4. Cast iron or ductile iron pipe, bituminous coated:

a. Provide one prime coat as specified below and finish with two coats of appropriate metal finish as specified in paragraphs 3.8.3.F.2 or 3 above.

b. Modified Aromatic Polyurethane Primer (Tnemec Series 1 Omnithane Primer, 3.0 dry mils, or equivalent by Sherwin Williams)

5. Non-ferrous metals:

a. Treat with manufacturer's recommended wash primer or pretreatment.

b. Provide finish coats as specified in paragraphs 3.8.3.F.2 or 3 above.

6. Galvanized surfaces:

a. System: Refer to (d) below.

b. Surface preparation: SSPC-SP1 Solvent Cleaning

c. One coat: Polyamide Epoxy (Tnemec Series 66-1211 Epoxoline primer, 3.0 dry mils, or equivalent by Sherwin Williams)

d. Finish with final coat as specified in paragraph 3.8.3.F.2 or 3 above

7. PVC piping systems:

a. System: Epoxy Polyamide

b. Surface preparation: Surface must be dry and clean.

c. 1st coat: Polyamide Epoxy (Tnemec Series 66 Hi-Build Epoxoline, 4.0 dry mils, or equivalent by Sherwin Williams)

d. Touch-Up Of Applied Coatings

G. Touch-Up Of Applied Coatings

1. Prior to any touch-up, the area is to be SP-3 brush cleaned.

2. Shop applied coatings:

a. Shop applied coatings with specified primer, as listed in Part F. above, shall be touched up with the same listed primer before any topcoat(s) are applied.

b. Shop applied coatings with manufacturer's standard paint for non-immersion shall be touched up with a compatible barrier coating, Moisture Cured Aromatic Urethane (Tnemec Series 530 Omnithane, or equivalent by Sherwin Williams)

H. Field applied coatings:

1. After cleaning, apply specified primer followed by specified finish coats.

I. Color Coding, Piping

1. Paint all exposed piping according to the color schedule selected by the Town.

J. Clean-Up

1. Upon completion of painting clean-up and remove from site all surplus materials, tools, appliances, empty cans, cartons, and rubbish resulting from painting work. Site shall be left in neat, orderly condition.
2. Remove all protective drop cloths and masking from surfaces not being painted.
3. Remove all misplaced paint splatters or drippings resulting from this work.

3.9 ALUMINUM CANOPY

3.9.1 GENERAL

A. Section includes: Aluminum roof cover and column system including fascia, beams, columns, roof deck and other components consisting of factory finished extruded aluminum.

B. Roof deck shall consist of extruded aluminum with interlocking flanges joined into a composite water tight unit.

C. Provide properly sized inserts to form column sleeve at concrete pier, typical every column.

D. Design Criteria: Each component and the completed assembly shall be designed to meet the requirements of the International Building Code (latest edition), the minimum load requirements provided on the Standard Drawings and all other applicable codes, regulations and standards.

E. All components shall be designed as a matching, complete and finished system.

F. Canopy system shall be designed and sealed by a South Carolina Registered Professional Engineer.

3.9.2 PRODUCTS

A. Canopy Requirements

1. Roof Panels – Extruded of self-supporting aluminum alloy panels with an interlocking design to provide a weather resistant load bearing deck with gage and depth as required to comply with design criteria.

2. Facia – Extruded aluminum alloy with 6” minimum depth. Depth and gauge shall be as required to comply with the design criteria.

3. Columns and Beams – Shall be aluminum alloy. Gage as required to comply with design criteria. Install deflectors and cutouts at designated columns.

4. Components – Brackets, trim and other accessories shall be of similar materials and finishes as specified for prime components.

5. Hardware – All bolts, nuts, washers and screws shall be compatible with aluminum framing and as required by the design. Provide neoprene or similar washers where required for water tightness.

6. Materials:

   a. All exposed surfaces shall be factory finished with matching colors. Colors as selected by owner. Owner has final decision on material color.

   b. Extruded Aluminum – 6063-T6.

   c. Reinforce as required to comply with design criteria if not per the design documents.

7. Finish – Baked on primer and polyester or similar enamel finish shall be provided. Finishes shall be applied and tested in accordance with the

quality standards specified by the Aluminum Associations latest publications of standards.

3.9.3 EXECUTION

A. Installation

1. Field verify dimensions, conditions and site elevations prior to fabrications.
2. Finished canopy must drain properly.
3. All joints must be tight and clean.
4. The canopy shall be erected plumb with all lines straight and true.
5. Provide grout as required to anchor column and fill void in column below water deflector.
6. Provide drains, weeps, deflectors and other components required to prevent standing water. Water drainage shall be directed from roof to ground in enclosed drainage.
7. Installed components shall be properly caulked with a suitable high quality material where required.
8. Touch up minor scratches and blemishes with paint matching the factory finishes. Replace material with major scratches, blemishes or other defects.

3.10 SUBMERSIBLE PUMPS

3.10.1 GENERAL

A. Section Includes: Submersible pump systems and accessories as specified herein.

B. Related Sections:

1. Piping, Valves, and Appurtenances.
2. Electrical.

C. Certificates:

1. Submit a guaranteed performance curve, signed by an officer of the pump manufacturing company.

D. Submittals:

1. Provide O & M Manuals for submersible pumps.

3.10.2 PRODUCTS

A. Pumps and Motors

1. Referenced Manufacturers

a. Pumps

i Sulzer Pumps, Inc. (Pete Duty & Associates, Ph: (803-276-3211).

2. Furnish and install the size and quantity of submersible non-clog wastewater pump(s) with accessories as set forth in the Design Requirements herein and as required to meet the operating conditions as determined by the Design Engineer in accordance with the Design Requirements herein and as approved by the Town. Each pump shall be equipped with a submersible electric motor of the size and type required and shall be suitable for use with variable frequency drives (VFDs), when VFDs are required by the Design Requirements. Each unit shall be rated for a discharge of _____ GPM at _____ Feet Total Dynamic Head (TDH).

3. The pump(s) shall be designed to pump raw, unscreened sewage and/or other fibrous pumpage without damage during operation. The pumps shall be capable of passing a three inch diameter sphere without damage to the pump or clogging of the pump. The pumps shall be of a non-overloading design, such that the pump shaft horsepower (BHP) shall not exceed the motor rated horsepower throughout the entire operating range of the pump performance curve.

4. Each pump shall be supplied with an automatic coupling system for easy removal of a pump for repair or replacement. The coupling system shall include an upper guide rail bracket, guide bar(s) or rail(s), sliding guide rail bracket and a mating cast iron guide rail discharge base elbow fitted with a standard ANSI 125# flange sized as shown on the drawings. The discharge base shall be permanently mounted in the wet well and connected to the discharge piping as shown on the drawings. The pumps shall be automatically and firmly connected to the discharge connection,

guided by Type 316 stainless steel guide bar(s) or rail(s) extending from the top of the station to the discharge connection. Intermediate guide rail support brackets shall be provided on deep wet wells. The sliding guide rail bracket shall be a separate part of the pumping unit capable of being attached to standard ANSI or DIN pump flanges so that the base is interchangeable with other pumps and not limited to a specific model or manufacturer of pump. Non-standard flange dimensions shall not be considered acceptable. Positive sealing of the pump to the discharge elbow shall be accomplished without the need for a service technician to enter the wet well to replace any parts. If a gasket is used for the seal, it shall be a field replaceable Nitrile rubber gasket mechanically held in place between the pump and sliding guide bracket

5. Each pump shall be fitted and equipped with a sufficient length of Type 316 stainless steel lifting chain or cable and hardware suitable for a rated working load of at least 50% greater than the pump unit weight. There shall be no need for personnel to enter the wet well.

6. Major pump components shall be of gray cast iron, ASTM A48, class 40 with smooth surfaces, free of blow holes, or other irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumpage other than the stainless steel shall be protected by a factory applied spray coating of alkyd primer with a chlorinated rubber paint finish on the exterior of the pump.

    a. The impeller shall be of grey cast iron, ASTM A48, class 40, dynamically balanced, double shrouded non clogging design having a long throughlet without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in wastewater. Whenever possible a full vaned impeller shall be used for maximum hydraulic efficiency. The impeller shall be retained by means of an allen head bolt, and shall be capable of passing a three inch diameter solid sphere. The impeller shall be coated with an alkyd resin primer.

    b. Pump volute shall be grey cast iron, Class 40, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. The minimum discharge size shall be as specified in the Design Requirements herein. The discharge flange shall permit attachment to standard ANSI or DIN flanges and appurtenances.

    c. Replaceable Type 316 stainless steel wear ring system shall be used to provide an efficient seal between the impeller and the volute.

7. The rotating assembly (impeller, shaft, and rotor) shall be dynamically balanced such that undue vibration or other unsatisfactory characteristics will not result when the pump is in operation at any speed greater than 40% of the pump's rated speed under any hydraulic condition.

8. Each pump shall be furnished with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal faces at a consistent rate. The lower, primary seal unit, located between

the pump and oil chamber shall contain one stationary and one positively driven ring made up of silicon carbide or tungsten-carbide. The upper, secondary seal unit, located between the oil chamber and the motor housing shall contain one stationary carbon, silicon carbide, or tungsten carbide seal ring and one positively driven rotating Cr-steel, silicon carbide or tungsten carbide seal ring. Each seal interface shall be held in place by its own spring system. The seals shall require neither maintenance or adjustment nor depend on direction of rotation for sealing. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug shall be readily accessible from the outside and shall be provided with a positive anti leak seal. The seal system shall not rely on pumped media for lubrication. The motor shall be able to operate dry without damage to the seal system.

9. Seal failure moisture sensors shall be provided in the seal oil chamber or stator chamber for detecting the presence of water. In addition, for motors larger than 33 HP, moisture sensors shall also be provided in the electrical connection chamber for detecting the presence of water. Each probe shall be connected to a solid-state module in the pump control panel. The solid-state devices shall send a low voltage, low amperage signal to the probes. If water enters the monitored chambers, the probe shall signal the solid-state device and energize an alarm to stop the motor and activate an alarm.

10. The pump and motor shaft shall be the same unit. The pump shaft shall be an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be AISI Type 420 stainless steel. The shaft shall be adequately designed to meet the maximum torque required at any startup condition or operating point in the system. The maximum deflection of the shaft shall not exceed 0.002 inches at the lower seal. Each shaft shall have a polished finish and have accurately machined shoulders to accommodate bearings, seals and impeller.

11. The pump shaft shall rotate on permanently greased lubricated upper and lower bearings. The upper bearing shall be a single deep groove ball or cylindrical roller bearing. The lower bearing shall be either one double row bearing or two single row bearings mounted in tandem. The lower bearing shall be a heavy duty angular contact ball bearing to compensate for axial thrust and radial forces and minimize shaft deflection. The calculated B10 bearing life rating shall be 100,000 hours minimum. Motors larger than 33 HP shall be supplied with bi-metallic sensors to monitor the temperature of the upper and lower bearings. These sensors shall be connected to the control panel such that when they open, the motor will stop and activate an alarm.

12. 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 premium efficiency inverter duty rated per NEMA standard MG-1 (part 31) to withstand 1600 volts peak and rise times of >0.1 μsec, and adequately sized so that the pump is non-overloading throughout the entire pump

performance curve. The motor shall be capable of operating with variable speed drives under full load to 50% speed completely unsubmerged without overheating or causing any damage to the motor. Where recommended by the pump manufacturer to allow permit adequate cooling, the motor shall be fitted with a cooling jacket to allow the pumped fluid or a non-toxic coolant such as propylene glycol to be circulated around the motor for cooling. The stator windings and stator leads shall be insulated with minimum moisture resistant Class F insulation rated for 311°F (155°C). The stator shall be dipped and baked three times in minimum Class F varnish and shall be heat shrink fitted into the stator housing. 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 of pumped media of 104°F (40°C) and capable of up to 12 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 260°F (125°C) 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 in series to the control panel such that when they open, the motor will stop and activate an alarm. The motor and pump shall be designed and assembled by the same manufacturer.

a. 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 104°F (40°C) ambient and with a temperature rise not to exceed 176°F (80°C). A performance chart shall be provided showing curves for torque, current, power factor, input/output KW, and efficiency. This chart shall also include data on starting and no-load characteristics.

b. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need for splicing. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

B. Pump Control Panel

1. All electrical work and controls shall be subject to the provisions of the NEC and shall be installed by licensed personnel.

2. The pump control panel as specified herein shall be capable of the operation of the number of submersible pumps required by the Design Requirements.

3. Enclosure:

a. NEMA 4X Type 316 Stainless Steel, either freestanding or with stainless steel floor stand kit, drip shield, door stop, hinged exterior door, easy open latches (no tools required) and padlocking provisions. Panel shall be provided with a hinged interior panel. All breakers,

lights, pushbuttons, switches, and accessories shall be visible and operable without opening the hinged interior panel.

4. Functional Requirements: The control panel shall be an automatic pump control center suitable for 480V (or other operating voltage as approved by the Town), 60 Hz., three-phase power. The panel shall provide the following features.

   a. Main power circuit breaker/disconnect switch.

   b. Surge suppressor – Transient surge protector (Eaton Model PTX-160 or equivalent) with indication lights and integral disconnect switch with 160 kA rating in a remotely mounted NEMA 4X enclosure.

   c. Phase monitor and lightning arrestor.

   d. Control power breaker.

   e. Separate breaker for each pump starter.

   f. Variable speed drives (VFD) as manufactured by Square D. Provide cooling fan on VFD.

   g. Air conditioning in pump control panel to prevent overheating (where necessary/required by the Town).

   h. Hand-Off-Auto switches for each pump.

   i. Run indication lights for each pump.

   j. Manual-Automatic speed selection switch for each pump.

   k. Manual and Auto speed indication lights for each pump.

   l. Manual speed potentiometer for each pump.

   m. Indication lights and reset buttons for motor failure of each pump on over temperature, seal failure, and VFD fail. Failure lights shall be latching until the reset button is pressed.

   n. Flashing alarm light, horn, and auxiliary contacts with test button, horn silence button and reset button.

   o. Auxiliary dry contacts shall be provided on all alarm indications for external use including, but not limited to, pump run, pump over temperature, pump seal failure, VFD fault, high level alarm, low level alarm, and power failure. Contacts shall be provided with both normally open and normally closed logic.

   p. Solid-state control relays for moisture probes in each pump.

   q. Terminal for thermal switches for over-temperature of each phase of the motor windings, upper bearings, and lower bearings for each pump.

   r. Running hour meters for each pump.

   s. Ammeter for each pump.

   t. Lead pump selection switch.

u. Oversized control power transformer large enough to serve the breakers in the panel.

v. Control power-indicating light.

w. Level transducer-float logic selection switch with indicating lights.

x. Programmable logic controller with HMI display panel, uninterruptible power supply, and sufficient number of discrete input, analog input, discrete output, and analog output modules, and relays, timers, switches, and other equipment as necessary to operate the pumps and other instrumentation according to the control scheme and monitor all functions associated with the operation of the facility as described herein and as shown on the drawings. The pump station operating sequence shall be as follows for duplex pump stations. In the event that the Design Requirements necessitate more than two (2) pumps, the sequence shall be modified accordingly.

   i Normal operation will allow the pumps to alternate between the lead and lag pump position upon each successive wetwell cycle. The lead pump shall be started upon reaching a predetermined lead pump on level. The lag pump shall be started if the wetwell level continues to rise to a predetermined lag pump on level. All pumps will stop when the wetwell reaches a predetermined pump off elevation. A selector switch shall be provided to determine which pump shall be the lead pump or whether they will alternate.

   ii Under normal operation, both the lead and lag pumps will vary their speed according to the level in the wetwell with adjustable tuning parameters.

   iii When the wetwell is below a predetermined level, there shall be an alarm indicating low water level and all pumps shall be locked out from operation in either the hand or automatic position until the wetwell level reaches at least the lead pump on level which shall unlock the pumps to operate. The low level alarm however will not reset until the reset button is pressed.

   iv An alarm condition will occur on a high level in the wetwell at a predetermined elevation.

   v The alarm will be provided with a panel mounted flashing light, panel mounted alarm horn, auxiliary contacts, a horn silence button, and an alarm reset button.

   vi In the HAND position, the selected pump shall operate independently from the alternation sequence but will not run if the wetwell is below the low-level alarm elevation.

   vii Upon resuming power after a power failure, the pumps will be provided with an automatic staggered restart of the equipment with a field adjustable time from 1 second to 99 seconds.

viii The level transducer shall provide level control under normal conditions and floats shall be used for backup operation in case of failure of the level transducer.

ix In the event the level controller fails to operate, 120 V controls shall be in place to provide basic functionality to control the on and off operation of the pumps based on the float control logic.

y. GFCI Convenience outlet.

z. Interior panel light with switch.

aa. Level/pressure transducer with 4-20 mA output – KPSI Series 700 or equal with 316 stainless steel construction with aneroid bellows. Unit shall be a maintenance free closed system.

bb. Mercury switch type wet well floats (quantity as required) with cable lengths no less than 50 feet to reach the junction box without splicing.

cc. Magnetic flow meter with 4-20 mA output. See “Magnetic Flow Meter” specified herein.

dd. Internally mounted space heater with thermostat.

ee. Internally mounted fan with thermostat (when air conditioner is not required).

ff. A 24 V dc power supply shall be provided and mounted in the pump control panel that will provide the power for all of the 4-20 mA signals. The power supply shall be capable of supplying a 750-ohm load on each signal loop. The power supply shall be fused on the primary and secondary sides of the supply. Each control loop shall be provided with surge protection and fusing such that a short or failure on one current loop will not affect the other current loops.

gg. In addition to the breakers provided due to the above requirements, at a minimum, the panel shall be equipped with circuit breakers as listed below. Minimum breaker sizes are provided below, actual breaker size will be dependent upon actual equipment sizes and final pump station electrical design.

i One (1) ea. 20 amp (minimum) breaker for exterior yard light

ii One (1) ea. 20 amp (minimum) breaker for canopy lights

iii One (1) ea. 20 amp (minimum) breaker for interior panel light

iv One (1) ea. 20 amp (minimum) breaker for panel mounted GFCI receptacle

v One (1) ea. 20 amp breaker (minimum) for RTU

vi One (1) ea. 20 amp breaker (minimum) for air conditioner

vii Two (2) ea. 20 amp breakers (spare)

viii One (1) ea. 20 amp breaker (minimum) for diesel pump battery charger GFCI receptacle

ix One (1) ea. 20 amp breaker (minimum) for diesel pump block heater.

x One (1) ea. 20 amp breaker (minimum) for magnetic flow meter.

3.10.3 EXECUTION

A. Preparation

1. Protect all equipment from damage due to weather or other construction activities. Follow all manufacturer's recommendations regarding storage of equipment prior to installation.

B. Installation

1. Pumps and other equipment shall be installed and securely mounted plumb and true inside the wetwell as established on the Standard Drawings and in strict accordance with the instructions and tolerances given by the manufacturer. After installation, pump alignments shall be checked and corrected if necessary. Excessive vibration or noise will not be allowed.

2. The completed installation shall be properly lubricated, checked, and the operating characteristics determined by the manufacturer's representative in the presence of the Town. Additionally, the amperage draw shall be checked at the design conditions for each pump unit. Upon inspection by the manufacturer's representative, a letter of certification shall be provided to the Town stating that the equipment has been installed in accordance with the manufacturer's recommendations and contains the certified results from all manufacturer's field testing.

3. All pump station piping shall be installed with braces, clamps, and supports furnished as required. All joints shall be perfectly watertight. Pipe shall be tested in accordance with the provisions of Section 3.4.

4. Electrical wiring, motors and controls shall be installed and electrically connected in accordance with the manufacturer's recommendations for the equipment supplied. All electrical work shall be subject to the provisions of the NEC and shall be installed by licensed personnel.

C. Performance Testing

1. Notify the Town 48 hours prior to flow rate testing.

2. Each pump shall be tested separately to verify that it delivers the required flow under actual field conditions. The pumps shall also be tested simultaneously to record the pumping capacity of both pumps operating in parallel. A copy of the test results shall be certified by the manufacturer's representative and provided to the Town along with the manufacturer's verification of installation.

3.11 BACK-UP PUMPING SYSTEM

3.11.1 GENERAL

A. Section Includes: Back-up pumping system and integral fuel tank with critical silenced enclosure and all accessories as specified herein.

B. The permanent skid mounted back-up pump specified herein shall be capable of pumping raw unscreened wastewater.

C. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.

D. Design Requirements:

Operating Speed (Max.): 2200 RPM (Unless Otherwise Approved By The Town)
Max. Solids Handling Size: 3 Inches (Unless Otherwise Approved By The Town)
Minimum Suction Size: 4 Inches (Unless Otherwise Approved By The Town)
Minimum Discharge Size: 4 Inches (Unless Otherwise Approved By The Town)

E. Maximum Suction Lift: 28 Feet

F. Duty Point: As Required For Pump Station Design Conditions

G. References:

1. ANSI B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings.

3.11.2 PRODUCTS

A. Manufacturer: Godwin (Xylem - Phone: 843-514-8932) Diesel Dri-Prime Backup System with CD Series Pump or equivalent product approved by the Town.

B. Equipment:

1. Casing, Suction Cover, Separation Tank: Pump castings shall be cast iron. Pump design shall incorporate a direct suction flow path that is in axial alignment with the impeller eye. There shall be no turns, chambers or valves between the suction flange and the impeller eye.

2. Impellers: The pump impeller shall be an open, 3-bladed, non-clog type with pump out vanes on the back shroud and fabricated from hardened cast chromium steel construction (minimum Brinell Hardness 200 HB).

3. Wearplates: Shall be fully adjustable and replaceable, fabricated of cast iron. Wearplate clearances shall have no relationship to the ability of the pump to achieve a prime.

4. Bearings And Shafts: Pump shall be fitted with a bearing bracket to contain the shaft and bearings. Bearings shall be tapered roller bearings of adequate size to withstand imposed loads for sustained pumping at maximum duty points. Minimum ISO L_{10} bearing life to be 100,000 hours. Impeller shafts shall be fabricated of 1.5% chromium alloy.

5. Seals: Seals shall be high pressure, mechanical self-adjusting type with silicon carbide faces capable of withstanding suction pressures to 50 psi. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. Pump shall be capable of

running dry, with no damage, for periods up to 24 hours. All metal parts shall be of stainless steel. Elastomers shall be Viton.

6. Pump Suction And Discharge Flanges: Cast iron ANSI (B16.1) Class 150, flat faced.
7. Pump Gaskets: Compressed fiber and/or Teflon.
8. Pump O Rings: Buna-N.
9. Priming System: Automatic priming system shall incorporate a twin-cylinder compressor and air ejector assembly, no vacuum pump. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjustment at high or low suction lifts. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system shall be capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts to 28 vertical feet, at sea level. It shall also be capable of operation using extended suction lines.
10. Check Valve: Pump shall have an integral swing type check valve mounted on the discharge of the pump allowing unrestricted flow from the impeller. The check valve shall prevent in-line return of flow when the pump is shut off. Refer to the Standard Drawings for check valve requirements.
11. Drive Unit: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be integral to the engine control panel. Battery shall have 180-amp hour rating. The engine control panel shall include a tachometer and an hour meter. Drive unit shall be a John Deere or equal, rated at the appropriate horsepower for the design duty point. A certified continuous duty engine curve shall be supplied to the Town.
12. Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode. See section 2.3 for Automatic mode.
13. Fuel Source: Fuel tank capacity shall be sufficient to provide at least twenty-four hours of operating time at full load. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
14. Exhaust: Exhaust system shall include a critical grade muffler of suitable size. Exhaust system shall have muffler and exhaust tubing sized to match maximum engine exhaust flow without exceeding engine manufacture's maximum allowable back pressure values.
15. Sound Attenuated Enclosure: The engine and pump shall be completely enclosed with 14 gauge sheet metal panels backed with 1" and 2" layers of polydamp acoustical sound deadening material. The acoustical enclosure

shall reduce pump and engine noise to sixty-eight dBA or less at a distance of 30 feet. The panels shall be removable for easy access to the engine / pump for maintenance and repair. The engine control panel shall have a locking door for visual inspection. For maintenance and service needs, the pump discharge side of the trailer shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.

16. Ul Listed Skid Base

    a. The pump base tank shall be a UL-142 approved double wall design constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110.

    b. The tank design shall be a closed top dike pump base tank. It shall be of double wall construction having a primary tank to contain the diesel fuel, held within another tank or dike, which is intended to collect and contain any accidental leakage from the primary fuel tank. The completed base tank assembly shall incorporate pump mounting locations and must be able to support four times the rated load.

    c. The primary tank shall be designed to withstand normal and emergency internal pressures and external loads. It shall be capable of withstanding internal air pressures of 3 to 5 psig without showing signs of excessive or permanent distortion and 25 psig hydrostatic pressure without evidence of rupture or leakage.

    d. The primary and secondary tanks or dike shall have venting provisions to prevent the development of vacuum or pressure capable of distorting them as a result of the atmospheric temperature changes or while emptying or filling. The vent shall also permit the relief of internal pressures caused by exposure to fires. The vent size shall be determined by using the calculated wetted surface area in square feet (the top is excluded) in conjunction with venting capacity table 10.1of UL-142. The tank's vent shall also be equipped with a coupling device and shall be located to facilitate connection to a vent piping system. The dike's vent may be an opening for venting directly to the atmosphere and protection from the entrance of natural elements or debris shall be provided.

    e. The primary tank is to be constructed of 7 gauge ASTM A569 or A-36 hot rolled steel. Internal baffles or reinforcement plates shall be located on a maximum of 24 inch centers in tanks up to 60 inch width and on a maximum of 19.5 inch centers in tanks over 60 inch width. At least one baffle shall separate the fuel suction pipe from the fuel return line.

    f. The outer tank is to be constructed in a manner to be able to support four times the wet load of the pump and housing. All of the load is to be carried by the outer tank so no load or vibration stress is placed on the primary tank. If the pump base tank is wider than the pump set to be supported, structural rails are to be incorporated to span the width

of the base tank so that the load is transferred to the side rails of the tank. Vertical reinforcements shall be welded to the outer sides of the secondary tank or dike at a maximum of 45 inch centers on tanks up to 30 inches high and on 24 inch centers on tanks greater than 30 inches high. At least one vertical reinforcement shall be positioned adjacent to each mounting hole location.

g. Both primary and secondary tanks shall be fitted with the proper welded pipe fittings to accommodate the requirements for the fill port and normal and emergency venting.

h. The completed assembly is to be cleaned with a heated pressure wash followed by a chromium free post treatment to ensure proper paint adhesion. The tank assembly is to be painted with an epoxy ester primer and high quality polyurethane enamel with total paint thickness of 3.5 mils. The painted tank assembly is to be baked at 180 degrees for 30 minutes to provide a hard durable finish.

i. Manufacturing and testing of this system shall be performed within the scope of Underwriters Laboratories, Inc. “Standard for Safety UL 142.” A UL label shall be permanently attached to the tank system showing the following information: The registered UL mark and the name: Underwriters Laboratories, Inc.; a control number and the word “listed”; the product’s name as identified by Underwriters Laboratories Inc.; the serial number assigned by Underwriters Laboratories, Inc.; other manufacturer’s information may also be included.

17. Factory Painting: Pump, engine, base, and skid shall be shop primed and finish painted at the place of manufacturer. Materials and thickness for priming shall be in accordance with manufacturer's standards.

C. Engine / Pump Control Specifications

1. The engine shall be started, stopped, and controlled by a factory installed microprocessor based state of the art digital controller supplied by the pump manufacturer. The controller shall be weather proof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats or a 4-20 mA transducer. The controller shall provide the following functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.

a. The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the panel.

b. The control panel shall function interchangeably from float switches, pressure switch, or transducer as well as manual start/stop by selection at the keypad.

c. The panel shall be capable of varying the engine speed to maintain a constant level in a process without a change to the panel other than via the keypad.

d. The start function can be programmed to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).

e. Manual-Automatic Button

i In Manual Mode, Manual "Start" button starts engine and runs until "Stop" button is depressed or an emergency shutdown occurs.

ii In Automatic Mode start/stop sequencing is initiated by either one-normally open and one-normally closed narrow angler float switches, pressure switch, transducer or a signal from a digital input.

f. The controller shall integrate the engine safety shut-off for low-oil temperature, high-temperature, and provide over-speed protection.

g. The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.

h. The panel shall have only one circuit board with 8 built in relays. Each relay can be named to provide any function all via the key pad without changing relays, chips, printed circuits or any hardware or software.

i. Standard components shall consist of (6) digital inputs, (8) analog inputs, (1) magnetic pick-up input, (6) 10-amp form "C" relays, (2) 20-amp form "C" relays, (1) RS485 port, (1) J1939 port, and (1) 320x240 pixel full graphic LCD display with backlight, (1) 12 position keypad, LCD lamps for visual indication of shutdown (red), warning (amber) and power (green).

j. The panel shall be designed to withstand a vibration of 3g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature range of 4° to 176°F (-20° to 80°C) and an operating humidity range of 0 - 95% non-condensing.

D. The unit shall include a fully automatic trickle charger powered by 6-amps, 115 VAC.

E. The drive unit shall be supplier with an integral thermostatically controlled engine block heater (15-amp, 115 VAC).

F. The unit shall include a single switch operated 12 VDC light within the enclosure.

3.11.3 EXECUTION

A. Manufacturers Services:

1. The manufacturer shall furnish the services of a competent factory representative to do the following:

a. Inspect the system prior to delivery, supervise the start up and testing of the system, and certify the system has been properly furnished and is ready for operation.

b. Instruct the Town's operating personnel in the proper operation and maintenance of the system.

B. An Operations and Maintenance manual shall be provided for the system.

C. Warranty

1. A copy of the engine manufacturer's parts and labor warranty shall be provided.

2. A one year Parts and Labor Warranty issued by the manufacturer of the backup pump system shall be provided covering all pump parts, including the mechanical seal.

3.12 INSTRUMENTATION

3.12.1 GENERAL

A. Section Includes: Process instrumentation and all accessories as specified herein.

B. Related Sections:

1. Piping, Valves, and Appurtenances.
2. Submersible Pumps (Pump Control Panel)
3. Electrical.

C. Certificates:

1. Submit a guaranteed performance curve, signed by an officer of the pump manufacturing company.

D. Regulatory Requirements

1. Conform to requirements of NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

3.12.2 PRODUCTS

A. Pressure Gauge

1. Provide pressure gauges where indicated on the standard drawings.

a. Provide rounded type case, 4-1/2" nominal diameter with phosphor-bronze bourdon tubes, glycerin filled, 1/4" HRT bottom male threaded connections stainless steel rack and pinion movement, black micro-adjusted corners and black figures with white plastic dials, and a threaded ring

b. Provide gauge accurate to within 1/2% of the total scale range.

c. Provide diaphragm isolators on all gauges.

i Provide diaphragm material resistant to chemicals in the process line being measured.

d. Select gauge at the range indicated on the drawings or at the nearest standard range which provides a top limit above the pump shutoff head at the operating conditions.

e. Each gauge connection to consist of a shutoff valve and 1/4" stainless steel piping connections.

i Shutoff valve to be 1-inch 316 stainless steel ball valve with Viton seals.

B. Magnetic Flow Meters:

1. Provide electromagnetic flow meter(s) as specified herein and as outlined in the schedule(s) below. Meters shall be equipped with a transmitter(s) suitable for indication and transmission of flow signal(s). The meter(s)

shall be installed in the location(s) given in the schedule below and as indicated on the Drawings.

2. Manufacturer: electromagnetic flow meter(s) shall be Model 8750WA as manufactured by Rosemount, Inc. or equal.

3. Magnetic Flow Meter Schedule (Sizes, Materials, etc.):

Quantity:	As Required
Meter Size:	As Required
Line Size:	As Required
Line Fluid:	Raw Wastewater
Temperature:	Ambient Water
Flowrate Range:	As Required

4. Construction Details:

   a. Liner Material: Polyurethane.

   b. Electrode Material: 316 Stainless Steel.

   c. End Connections: 150 lb Flanges.

5. Meter Construction:

   a. The flow meter(s) shall be microprocessor based electromagnetic flow meter utilizing the latest high frequency bi-polar pulsed 4-20 mA DC technology. The meter shall have 150-lb flanges. The flow tube shall be rated for pressure up to 1.1 times the flange rating of the adjacent piping. The flow sensor shall be housed in steel housing. The meter shall be provided with grounding rings in order to ensure accuracy. The liner shall have a minimum thickness of 0.125 inches. The system shall be rated for a ambient temperatures of -30 to +65°C.

6. Metering Design and Performance:

   a. The meter shall indicate instantaneous flowrate, total flow, and transmit flow signals. The required flow measuring accuracy is 0.5 percent over the flow velocity range of 1.0 to 33.8 ft/s with a minimum turndown of 100:1. The minimum required liquid conductivity shall not be greater than 5 µS/cm. The flow meter shall be factory calibrated and the accuracy verified. The meter manufacturer shall furnish a certificate of accuracy. The flow meter shall be inherently bi-directional.

7. Flow Transmitter:

   a. The transmitter shall be integrally mounted in a NEMA 4X enclosure. The transmitter shall indicate in user-defined units the instantaneous flowrate and total flow in a 3/8” character, 2-line 16-digit backlit display. The unit shall maintain the totalized flow and programmed configuration in memory for a minimum period of 10 years. The transmitter shall utilize "smart" electronics and contain automatic, continuous zero correction signal processing routines for noise rejection. The preamplifier input impedance shall be a minimum of

109-1011 ohms making the system suitable for the amplification of low-level input signals. An automatic low flow cutoff below a user configurable low flow condition shall be provided. The outputs shall be capable of being forced to zero by an external contact operation. All menu advice and commands shall be visible on this display. The display shall be modular and rotatable 360 degrees, in 90 degree increments. Provide outputs as required.

8. Other Features:

   a. The flow meter shall allow for menu selection and make changes from outside the housing. It shall not be necessary to remove covers, panels, or fasteners to accomplish calibration or program changes.

   b. The meter shall feature non-volatile EEPROM memory and universal electronics module compatibility.

   c. All printed circuit boards shall be contained in a plug-in module and be interchangeable for any size without requiring test equipment.

   d. The flow meter electrodes on ceramic liners shall be fused platinum and shall not require O-rings.

   e. The flow transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal.

3.12.3 EXECUTION

A. General:

   1. Handle in accordance with manufacturer's written instructions. Handle carefully to avoid damage to components, enclosure, and finish.

B. Installation:

   1. Perform all wiring in compliance with NEC.

   2. Installation shall be where indicated, in compliance with manufacturer's instructions, drawings and recommendations NEMA ICS 3.1.

C. Mount equipment securely on equipment rack using type 316 stainless steel hardware.

3.13 ELECTRICAL – BASIC MATERIALS AND METHODS

3.13.1 GENERAL

A. Section Includes: Basic materials and methods for pump station electrical systems

B. References:

1. NFPA 70 - National Electrical Code (NEC) – Latest Edition.
2. NEMA ICS 1 - Safety Guidelines for the Application, Installation and Maintenance of Solid State Control.
3. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
4. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
5. Institute of Electrical and Electronics Engineers (IEEE)
6. Underwriters Laboratories (UL)
7. NFPA 820 – "Standard For Fire Protection In Wastewater Treatment and Collection Facilities"

C. Provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment listed by UL wherever standards have been established by that agency.

D. Electrical equipment and system components located in and adjacent to wetwell shall comply with the requirements for Class 1, Division 1/Class 1, Division 2 service as defined in NFPA 820.

3.13.2 PRODUCTS

A. Service Entrance

1. Provide materials and work, as required by the electric utility which will provide service to the facility, for installation of service conductors, and mounting of utility company equipment. All such materials and work shall meet the requirements of the utility company.

B. Outlet And Device Boxes

1. General: Provide boxes not less than 2 inches deep. Do not use box extensions to provide wiring space required by the NEC.
2. Cast Aluminum (CA) Boxes: Cast aluminum shall be gasketed with watertight, cast aluminum covers and stainless steel screws. Provide boxes with threaded conduit hubs and cast mounting lugs where lugs are required.
3. Nonmetallic (NM) Boxes: PVC boxes shall be gasketed with watertight covers and stainless steel screws. Provide boxes with conduit hubs and any required mounting lugs.

C. Junction And Pull Boxes

1. Use minimum NEMA 4x - 316 stainless steel watertight enclosures.

D. Wiring Devices

1. Switches:

a. General Use Switches: Specification grade, totally-enclosed, ac type, quiet tumbler switches meeting NEMA WD 1 performance standards and Federal Specification W-S-896E, rated at 20 amps, 120/277 volts. Provide weatherproof switches in a cast metal box with gasketed plate as specified.

2. Receptacles:

a. Ground Fault interrupter (GFI) Receptacles: Duplex specification grade GFI receptacles tripping at 5 milliamps; rated 20 amps, 120 volts, NEMA Configuration 5-20R. Use units meeting NEMA WD 1, fitting standard sized outlet boxes, having provision for testing. Use standard model where ground fault protection is needed. Do not use feed-thru model. Provide in a weatherproof enclosure

3. Device Plates:

a. Weatherproof Plates:

i Provide weatherproof gasketed, cast metal or stainless steel cover plate UL listed with individual cap over each receptacle opening and stainless steel mounting screws. Utilize plates with caps held tightly closed with stainless steel springs when receptacle is not in use.

ii Provide weatherproof gasketed cast metal or stainless steel switch cover incorporating an external operator for the internal switch and with stainless steel mounting screws.

E. Circuit Breakers, Individual, 0 To 600 Volts

1. General: Provide circuit breakers of the indicating type showing ON/OFF and TRIPPED positions of the operating handle. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting the requirements of NEMA AB 1. Circuit breakers shall have a minimum interrupting rating equal to the maximum fault current available at the point of application or they shall be part of an assembly with an integrated equipment short circuit rating at least as great as the fault current available at the point of application. Where circuit breakers are used as service entrance equipment, provide units UL labeled for that use. Provide circuit breakers suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

F. Pushbuttons, Indicating Lights, And Selector Switches

1. For nonhazardous, outdoor, or normally wet locations, provide heavy-duty corrosion-resistant, watertight type pushbuttons, or indicating lights, or selector switches mounted in NEMA 4X watertight enclosures. Provide special gasketing required to make complete station watertight.

2. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra-large nameplates indicating their specific function. Provide pushbutton stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated.
3. Utilize selector switches having standard operating levers. Make all indicating lights transformer push-to-test type.

3.13.3 EXECUTION

A. Outlet And Device Boxes

1. Provide a box suitable for the conditions encountered at each outlet in the wiring or raceway system and sized in accordance with the NEC.

B. Junction And Pull Boxes

1. Where necessary to terminate, branch-off, or redirect multiple conduit runs or where otherwise required, provide and install appropriately designed junction boxes. Furnish and install pull boxes where necessary in the raceway system to facilitate conductor installation. Provide pull boxes to limit conduit runs to less than 150 feet and to contain no more than the equivalent of three right-angle bends.
2. Installation:
    a. All boxes shall be accessible. Mount all boxes plumb and level.
    b. Install boxes in a secure, substantial manner, supported independently of conduit by attachment to a unistrut support or structural member.
    c. Install boxes for conduits under grade flush with finished grade in locations outside of paved areas, roadways, or walkways.

3.14 ELECTRICAL – RACEWAYS

3.14.1 GENERAL

A. Section Includes electrical raceway systems.

B. References

1. NFPA 70 - National Electrical Code.

3.14.2 PRODUCTS

A. Galvanized Rigid Conduit (GRC)

1. Use Galvanized rigid steel conduit, including couplings, bushings, elbows, nipples, and other fittings, hot-dip galvanized and meeting the requirements of UL and the NEC. Do not use setscrew type couplings, bushings, elbows, nipples, and other fittings, unless approved by the Engineer. Galvanized rigid steel conduit shall be threaded on both ends and threads shall be hot-dip galvanized after cutting. Shall be produced in accordance with UL safety standard #6 and ANSI C80.1.

B. PVC Schedule 40 Conduit

1. Use rigid PVC Schedule 40 conduit, UL listed for concrete-encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90 degrees C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL, NEC, and ASTM specified tests for the intended use. Use only conduit with a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable.

C. Flexible Metal Conduit, Liquid-Tight

1. Use UL listed liquid-tight flexible metal conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.

D. PVC Coated Galvanized Rigid Conduit

1. NEMA RN-1 or UL-6 rigid steel conduit with factory applied external 40 mil PVC coating and urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. All couplings, fittings, conduit bodies, pipe straps, U bolts, beam clamps, flex connections and other accessories shall have factory applied PVC coating. Use PVC coated hubs for connection of coated conduits – locknuts are not acceptable.

E. Warning Tape

1. Provide heavy-gauge, red plastic tape of 6-inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant

to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape.

3.14.3 EXECUTION

A. General

1. Provide raceway systems meeting or exceeding the requirements of the NEC.
2. Minimum Raceway Size: Use no circular raceway less than 3/4 inch.

B. Required Raceway Type For Location And Installation Method

1. Exterior, Exposed: PVC Coated GRC
2. Underground, Direct Earth Burial: PVC Schedule 40 conduit.
3. Embedded In Concrete: PVC Schedule 40 conduit.

C. Special Locations:

1. Use PVC Coated GRC:
   a. Where conduit changes from underground and/or concrete embedded to exposed.
   b. Under equipment mounting pads.
   c. In exterior light pole foundations.

D. General Installation Requirements For Raceways

1. Location, Routing, and Grouping:
   a. Group raceways in same area together. Locate raceways at least 12 inches away from parallel runs of other utility systems.
   b. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes to provide a neat appearance. Follow surface contours as much as possible.
   c. Avoid obstruction of passageways. Run concealed raceways with a minimum of bends in the shortest practical distance.
   d. In outdoor, underground, or wet locations, use watertight couplings and connections in raceways. Install and equip boxes and fittings so as to prevent water from entering the raceway.
   e. Locate above ground raceways concealed in cast in place concrete so that the minimum concrete covering is not less than 1-1/2 inches.
   f. Avoid trapped runs, where possible. Aboveground trapped runs shall have a drain fitting installed at the low point.
   g. Except at raceway crossings, separate raceways in slabs not less than six times the raceway outside diameter.
   h. Install concealed, embedded, and buried raceways so that they emerge at right angles to the surface and have none of the curved

portion of the bend exposed. Provide support during pouring of concrete to ensure that raceways remain in position.

2. Bushing and Insulating Sleeves:

   a. Where metallic conduit enters metal equipment enclosures through conduit openings, install a bonding bushing on the end of each conduit. Install a bonding jumper from the bushing to any equipment ground bus or ground pad.

   b. If neither exists, connect the jumper to a lag-bolt connection to the metallic enclosure.

   c. Use manufacturer's standard insulating sleeves in all metallic conduits terminating at an enclosure.

3. PVC Conduit: Chamfer the end of all PVC conduit. Solvent weld PVC conduit joints with solvent recommended by the conduit manufacturer. Follow manufacturer's solvent welding instructions and provide watertight joints. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings. Use acceptable PVC female adapters when joining PVC conduit to rigid metal conduit.

4. Penetrations:

   a. Seal the interior of all raceways entering structures at the first box or outlet with oakum or suitable plastic expandable compound to prevent the entrance into the structure of gases, liquids, or rodents.

   b. Dry pack with nonshrink grout around raceways that penetrate concrete walls or floors.

3.15 ELECTRICAL - VARIABLE FREQUENCY DRIVES (VFDs)

3.15.1 GENERAL

A. Section Includes: Requirements for variable frequency drives for use with NEMA B design AC motors.

B. VFD manufacturer shall furnish, field test, adjust and certify all installed VFDs for satisfactory operation.

C. References: The VFD and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of IEC, UL, and NEMA and shall comply with NFPA 70 (National Electric Code) latest editions.

D. Operation and Maintenance Manuals with instructions for operation of units shall be provided prior to acceptance by the Town and shall include the as-built dimensioned drawings, schematic diagrams and power and control connection diagrams and product data sheets.

E. Qualifications: VFD manufacturer shall be ISO 9001 or 9002 certified.

F. Quality Assurance: VFD and all associated optional equipment shall be UL 508A or UL 61800-5-1 (508C) listed. A UL label shall be attached inside each enclosure as verification.

G. VFD shall be designed, constructed and tested in accordance with NEMA, NEC, VDE, IEC standards and CSA certified.

3.15.2 PRODUCTS

A. VFD shall be provided by Square D.

B. Construction

1. Adjustable frequency drives 1 through 25 horsepower (HP) shall have the following features:

   a. The VFD shall be rated 480 V AC (optional input voltages of 208, 240, and 575V AC). Operating voltage will be determined by the design engineer based on site conditions and approved by the Town. The VFD shall provide microprocessor-based control for three-phase induction motors.

   b. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output.

   c. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

   d. Insulated Gate Bipolar Transistors (IGBTs) shall be used in the inverter section. Bipolar Junction Transistors GTOs or SCRs are not acceptable.

   e. The VFD shall have an efficiency at full load and speed that exceeds 95% for AC Drives below 15 Hp and 97% for drives 15 Hp and above. The efficiency shall exceed 90% at 50% speed and load.

f. The VFD shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.

g. The VFD shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250% for constant torque drives. The VFD shall have a one (1) minute overload current rating of 150% for variable torque drives. Coordinate required drive torque with Engineer for each application.

h. The VFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.

i. The VFD shall have a 3% nominal impedance integral AC three-phase line reactor.

j. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.

k. The VFD shall be capable of converting single phase incoming power to three phase output power. Provide additional capacitance kit and other accessories as necessary.

2. Adjustable frequency drives 26 through 1000 horsepower (HP) shall have the following features:

a. The VFD shall be rated for 480 V AC (unless otherwise approved by the Town). The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 50 degree C ambient at 250HP and below and 40 degree ambient above 250HP VT and no less than a 3.6 kHz switching frequency to reduce motor noise and avoid increased motor losses. Drive shall have been tested to and UL listed as conforming to the requirements of UL508C at rated load currents and ambient temperature per this specification. Drive shall have a UL listed interrupting rating of 65kaIC.

b. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation.

c. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not acceptable. The VFD shall run at the above listed switching frequency.

d. The VFD shall have an efficiency at full load and speed that exceeds 95%. The efficiency shall exceed 90% at 50% speed and load. The VFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.

e. Provide 18 pulse VFDs where required by the Town. The use of harmonic filter traps, 12 pulse rectifiers, Active filters or Active converter sections is not an acceptable substitute to the 18 pulse drive.

f. The VFDs shall have a one (1) minute overload current rating of 110% for variable torque loads or 150% for constant torque loads. Coordinate required drive torque with Engineer for each application.

g. The VFDs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.

h. The transformer shall be a single wound transformer rated 480 Volts with a UL recognized 180 degree C insulation system. Required performance shall be obtained without exceeding the above indicated temperature rise in a 50 degree C ambient below 250HP and for 40º C maximum ambient above 250HP.

i. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.

3. The VFD shall be mounted in NEMA Type 1 enclosures for drives mounted inside control panels and NEMA Type 4X Stainless Steel for units mounted outdoors. The drive shall be supplied with an externally operated lockable disconnect device. The enclosure shall be sized such that all required devices are mounted within the drive enclosure.

4. A mechanical interlock shall prevent an operator from opening the VFD door when disconnect is in the ON position. Another mechanical interlock shall prevent an operator from placing disconnect in the ON position while the VFD door is open. Provisions shall be provided for locking all disconnects in the off position.

C. Application Data

1. The VFD shall be sized to operate a variable torque, variable torque low noise, constant torque, constant horsepower, or impact load as required by the type of equipment being operated. Unit shall be sized to handle the hardest starting load for the type of equipment driven.

D. Control Functions

1. Frequently accessed VFD programmable parameters shall be adjustable via a digital operator keypad located on the front of the VFD.

2. The user shall be able to control the Hand-Off-Auto position of the VFD through a switch located on the unit. In Hand mode, the user shall be able to control the motor speed through the potentiometer located on the unit.

E. Protection

1. The VFD shall be UL 508C listed for use on distribution systems with 65,000A RMS available fault current. The power converter shall be able to withstand a short circuit current of 65,000 RMS symmetrical amperes as defined by NEMA ICS 7.1.09 and have the value listed on the VFD nameplate.
2. The power converter shall be protected against short circuits, between output phases and ground; and the logic and analog outputs.
3. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 5 programmable restart attempts. The programmable time delay before restart attempts will range from 1 second to 600 seconds.
4. The deceleration mode of the VFD shall be programmable for normal and fault conditions. The stop modes shall include freewheel stop, fast stop and DC injection braking.
5. Upon loss of the analog process follower reference signal, the VFD shall fault and/ or operate at a user defined speed set between software programmed low speed and high-speed settings.
6. The VFD shall have solid state I^2t protection that is UL listed and meets UL 508 C as a Class 10 overload protection and meets IEC 947. The minimum adjustment range shall be from 0.45 to 1.05 percent of the current output of the VFD.
7. The VFD shall include Metal Oxide Varistors (MOVs) wired to the incoming AC Mains for phase to phase and phase to ground protection.

F. System Interfaces

1. Provide programmable digital inputs and outputs, analog inputs and outputs and serial communications interface to allow interface with drive for remote control and monitoring.
2. Provide LCD display on VFD capable of displaying drive status indication, monitoring parameters and diagnostic features.
3. Provide a communication card for Ethernet/TCP interface.

3.15.3 EXECUTION

A. Factory Testing and certifications

1. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
   a. All final assemblies shall be tested at full load on a dynamometer for a total run time of 2 hours minimum. The adjustable frequency drive shall trip electronically without device failure. The manufacturer shall provide certified copies of factory test reports.
2. A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations

B. Installation

1. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations and all applicable codes and standards.