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SECTION 02560

HORIZONTAL DIRECTIONAL DRILLING (HDD) INADVERTENT RELEASE CONTROL PLAN (IRCP)

PART 1 – GENERAL

1.1 DESCRIPTION

Installation of a pipeline using a trenchless excavation method is known as horizontal directional drilling (HDD). A primary environmental impact potentially associated with HDD is inadvertent release of drilling fluids/mud (water/bentonite mixture) to the surface during construction (sometimes referred to as "frac-out"). Objective of this section is to provide procedures which will minimize the potential for release of drilling fluids/mud into wetlands, waterbodies or onto adjacent surface soils.

1.2 SCOPE OF WORK

HDD is to be conducted in accordance with an Inadvertent Release Control Plan (IRCP). As such, HDD will be conducted in a manner to prevent inadvertent releases of drilling mud. Contractor shall have a written IRCP which shall address the "Containment, Response and Notification". This plan shall elaborate on measures to be implemented if a release occurs despite prevention efforts. The plan is to be implemented if a release occurs despite prevention efforts. The plan is to be implemented as appropriate by the Contractor under supervision of Regulatory Agencies to contain, control and clean up any release of drilling mud during HDD pipeline construction. Prior to commencement of HDD operations, Contractor shall inform construction personnel involved in HDD as to the responsible party(ies) for release containment and response. Contractor will ensure the appropriate response personnel and containment equipment are on site for each HDD. A copy of the plan shall be submitted to Owner and Engineer for review prior to any drilling taking place. A copy of the plan shall be onsite during drilling activities.

At a minimum, sediment control devices and spill control barriers (such as straw bales, silt fence or similar) shall be erected between the bore site and nearby areas such as wetlands, rivers, and critical lines to prevent material from reaching these areas. The drilling entry and exit areas will be surrounded by a barrier and/or sediment control device to control spill. These devices shall be as approved by the Regulatory Agencies. All barriers shall be installed according to the Regulatory Agency requirements.

Prior to initiating construction activities, Owner, Engineer and Contractor will review applicable permits to ensure Contractor and all personnel involved are made aware of and understands the permit and its requirements, including any special conditions of the permit, monitoring of the project required by the permit, implementation of the IRCP (frac-out) Response Plan and the implementation of Best Management Practices (BMP) during all phases of construction which are designed to prevent release of sediment or deleterious substances into adjacent wetlands or waterways. It is the responsibility of Owner to initiate this meeting. Additionally, wetland boundaries will be marked in the field and silt fencing will be established along these boundaries by Contractor prior to any other land disturbing activities on site.

1.3 MEASUREMENT AND PAYMENT

No separate payment will be made for preparation and/or implementation of the IRCP, including but not limited to plan preparation, observation, response, agency notifications, cleanup, containment, etc. Payment shall be incidental to cost of HDD work and considered a subsidiary obligation of the contract.

1.4 ON-SITE OBSERVATION DURING CONSTRUCTION

- A. During construction of a directionally-drilled crossing, pipeline construction personnel will monitor pipeline route throughout the process, as follows:
1. The drill path will be continually monitored during active drilling with mud circulation;
 2. Construction observers will be briefed on what to watch for and will be made aware of the importance of timely detection and response actions to any release of drilling mud;
 3. Construction observers will have appropriate, operational communication equipment (e.g. radio, cell phones) available at all times during installation of the directionally drilled crossing, with ability to communicate directly with HDD operations control center;
 4. If HDD operator realizes a sustained loss in fluid pressure or loss of circulation, operator will immediately notify construction observers of the assumed position of drill head and forward drilling progress will be temporarily suspended until area is reviewed;
 5. Construction observers will have the authority to order installation of containment structures, if needed, and to require additional response measures if deemed appropriate;
 6. Contractor shall maintain records on drilling fluid pumping rates, pressure, viscosity, density, etc. throughout the course of drilling; and
 7. If drilling at night is required, appropriate lighting shall be provided.
- B. Monitoring the project site during all phases of construction will be conducted by Contractor. Contractor will visually inspect the project site at least twice daily (AM and PM) for compliance with BMP's and to ensure work is proceeding as permitted and conditions are such that problems are not anticipated and an inadvertent release or frac-out has not occurred. Inspection logs will be maintained on-site and will contain the date and time of all inspections and will note any problems or potential problems or other items of interest. All actions occurring on-site causing problems with work or a temporary stop in work will be noted in the log. Daily photographs will also document progress of work, the integrity of any sediment control measures and compliance with permit conditions.

1.5 RESPONSE TO INADVERTENT RELEASES

- A. If an inadvertent drilling mud release is observed during an HDD crossing, the release will be assessed to determine amount of drilling mud being released and potential for release to reach sensitive resource areas (e.g. wetlands and waterbodies). Response measure will vary based on location of inadvertent release as discussed below.

1. Upland Locations:

Response measures include:

- a. Evaluate release to determine if containment structures are warranted and if they will effectively contain the release;
- b. Order installation of containment measures as needed (see Section 1.6); and
- c. Initiate immediate suspension of drilling operations if the mud release cannot be effectively contained.

2. Wetland Location:

This section also applies to areas immediately adjacent to wetlands and waterbodies, such as stream banks or steep slopes, where drilling mud releases could quickly reach surface water.

Response measures include:

- a. Evaluate release to determine the most effective containment measures;
- b. Order installation of containment measures (see Section 1.6);
- c. Initiate immediate suspension of drilling operations if the mud release cannot be effectively contained;
- d. Review and adjust drill pressures, pump volume rates, and drill profile to minimize extent of the release;
- e. Further evaluate the current drill circumstances and site conditions to identify potential means to prevent further inadvertent release events; and
- f. If necessary, suspend drilling operations in accordance with Section 1.6 and in consultation with the Owner and Engineer, and notify appropriate regulatory agencies in accordance with Section 1.7.

1.6 CONTAINMENT

A. Containment, response and clean-up equipment will be available at both sides of HDD crossing location prior to commencement of HDD to assure a timely response in the event of an inadvertent release of drilling mud (i.e. frac-out). Containment and response equipment includes but is not limited to:

1. Straw bales, sediment logs, and staking;
2. Silt fence;
3. Plastic sheeting;
4. Shovels and other appropriate hand tools;
5. Squeegees;
6. Pails;
7. Push brooms;
8. Pumps and sufficient hose;
9. Mud storage tanks;
10. Vacuum truck on 24-hour call or on site;
11. Pre-filled sandbags;
12. Geotextile fabric;
13. One small boat (for larger rivers and open water wetlands);
14. Steel box or large-diameter pipe section (or the equivalent) that, under appropriate conditions, could be used to contain a frac-out;
15. Floating containment booms;
16. Standby power; and
17. Lights for possible work at night.

B. Contractor will immediately implement measures to contain any release of sediment or other deleterious substance into adjacent wetlands or waterbodies.

Upland Locations:

1. Deploy appropriate containment measures to contain and recover drilling mud as feasible;
2. Remove excess mud at a rate sufficient to prevent an uncontrolled release;

3. If the amount of surface release is not great enough to allow practical physical collection from affected area, it shall be diluted with clean water and/or allowed to dry and dissipate naturally; and
4. If the amount of surface release exceeds that which can be completely contained with hand-placed barriers, small collection sumps (less than 5 cubic yards) may be used to remove released drilling mud by use of portable pumps and hoses.

C. Wetland and Waterbody Locations:

This section also applies to areas immediately adjacent to wetlands and waterbodies, such as pond edges, stream banks or steep slopes, where drilling mud releases could quickly reach sensitive water resource areas.

1. In the event of a drilling mud release in wetlands, waterbodies, or adjacent areas:
 - a. The release will be evaluated, and appropriate containment measures will be deployed;
 - b. Emergency containment measures will be deployed as feasible, based on site-specific conditions, including location of the release;
 - c. Following containment, recovery measures will be evaluated to determine the most effective collection method;
 - d. Drilling operations will be suspended if, as determined by Owner, containment measure do not effectively control the release; and
 - e. Agency and project management personnel will be notified in accordance with Section 1.7.
2. Owner and Contractor shall immediately consult with appropriate regulatory agencies to evaluate circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions HDD may proceed (see Section 1.8);
3. If the amount of surface release is not great enough to allow practical physical collection from affected area without causing additional impacts, it shall be diluted with clean water and/or allowed to dry and dissipate naturally;
4. If the amount of surface release exceeds that which can be contained with hand-placed barriers, small collection sumps (less than 5 cubic yards) may be excavated to collect released drilling mud for removal by use of portable pumps and hoses;

5. Excess mud will be held within the containment area and removed using pumps or other appropriate measures at a rate sufficient to maintain secure containment;
6. Removed mud will be stored in a temporary holding tank or other suitable structure out of the floodplain and/or wetland for reuse or eventual disposal in an acceptable disposal facility;
7. If spill affects a vegetated area, the area shall be seeded and/or replanted similar to preconstruction conditions. Re-vegetation must be successful within the warranty period or Contractor shall replant at no additional cost to Owner.

1.7 NOTIFICATION AND RESUMPTION OF SUSPENDED HDD OPERATIONS

For all drilling mud releases during HDD crossings, Contractor will notify Engineer and Owner immediately. If Engineer determines the release affects wetland or in-stream area, he or she will immediately notify Owner and appropriate regulatory agencies.

If notifications are necessary during non-business hours they will be done according to prior arrangements made between the Owner and regulatory agencies. Follow-up notifications will be made as necessary and practicable.

The conditions under which HDD operations can resume will be discussed with appropriate regulatory agencies and/or field representatives. If containment measures are functioning, and circumstances and potential impacts of the release are understood, HDD operations may resume.

1.8 CLEAN-UP

- A. Clean-up measures following mud releases in uplands, wetlands, and waterbodies will be implemented as determined by this plan and in consultation with the appropriate regulatory agencies. Contractor shall coordinate with governing regulatory agencies, Owner and Engineer to determine the appropriate method for cleaning up affected areas and appropriate methods for disposing of sediment or deleterious substances. The following measures are to be considered as appropriate:
 1. Drilling mud will be cleaned up by hand shovels, buckets and soft-bristled brooms as possible without causing extensive ancillary damage to existing vegetation. Clean water washes may also be employed if deemed beneficial and feasible;
 2. Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or ancillary damage to existing and adjacent vegetation;
 3. Material will be collected in containers for temporary storage prior to removal from the site; and
 4. Potential for secondary impact from clean-up process is to be regularly evaluated and clean-up activities terminated if physical damage to the

site is deemed to exceed benefits of removal activities in consultation with appropriate regulatory agencies and/or field representative.

5. Water containing mud, silt, bentonite or other pollutants from operations, washing or other clean-up activities, shall not be allowed to enter any waterbody, marsh or wetland area. Also all such pollutants shall be cleaned up.

1.9 RESTORATION AND POST-CONSTRUCTION MONITORING

Following clean-up activities, restoration and re-vegetation of affected areas will be completed by Contractor to restore the site to equal or better than its original condition. All affected areas will be fully stabilized and re-vegetated as appropriate. The site will be reviewed during warranty period to assure adequate restoration. If the site does not restore to equal or better than original conditions, subsequent re-vegetation shall be made by Contractor as part of warranty work.

1.10 ABANDONMENT PLAN

If for any reason, it becomes necessary to suspend HDD operations and/or abandon partially completed drill holes, the following procedures will be implemented:

A. During Pilot Hole Drilling:

If drilling is suspended during reaming of the hole;

1. If possible, reamer will be pushed back to the exit end, then:
 - a. Reamer will be replaced with a cementing head; and
 - b. Drill string will be withdrawn and the hole will be pumped with cement or Engineer and industry-accepted fill material to displace drilling fluid.
2. If reamer cannot be pushed back to the exit end, then:
 - a. Drill string will be withdrawn and the hole will be pumped with cement or Engineer and industry-accepted fill material to displace drilling fluid;
 - b. Drilling rig will rig down at the entry end and rig up at exit end;
 - c. Drilling rig will run in the pilot hole with cement head on pilot hole drill string until previously cemented reamed hole is bumped; and
 - d. Drill string will be withdrawn and hole pumped with cement or Engineer and industry-accepted fill material to displace the drilling fluid.

B. HDD Realignment:

If it is found necessary to abandon original location, the proposed alignment will

be modified to accommodate a new drill. The proposed new exit and entry areas will be surveyed for sensitive biological and cultural resources, and agencies with regulatory control will be contacted to amend permits as needed.

In case of abandonment, an additional attempt at completing the horizontal direction drill may be made in proximity to previous route. A new hole will be drilled in the same general area as initial drill hole. No alternative crossing method will be implemented (i.e. wet trench) without the proper agency notification and permits. All work will occur at no additional cost to the Owner.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 IRCP

Contractor shall prepare a written IRCP and submit it to Owner, Engineer and regulatory agencies for concurrence. The IRCP shall be revised to include all comments from these entities and final IRCP shall remain on site. HDD Project Superintendent shall be familiar with the IRCP and shall have authority to implement it.

END OF SECTION

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SECTION 02570 – TRAFFIC CONTROL

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SECTION 02570
TRAFFIC CONTROL

PART 1 – GENERAL

1.1 DESCRIPTION

- A. This section covers furnishing, installation, and maintenance of all traffic control devices, portable signal equipment, warning signs, and temporary traffic lanes used during construction of the project.

1.2 RELATED WORK

- A. Section 02200 – Earthwork
- B. Section 02550 – Water Distribution System
- C. Section 02554 – Wastewater Collection System

1.3 RESPONSIBILITY

- A. The Contractor shall furnish, install, and maintain all necessary automated signals, barricades, concrete traffic barriers, warning signs, traffic barriers, traffic lanes, and other protective devices. Ownership of these temporary warning devices shall remain with the Contractor provided devices are removed promptly after completion and acceptance of work to which devices pertain. If such warning devices are left in place for more than 30 days after specified time for removal, Owner shall have the right to remove such devices and to claim possession thereof.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. All barricades signs, and traffic control signal devices shall conform to requirements of the current Georgia Manual on Uniform Traffic Control Devices except as may be modified in these project specifications.
- B. Portable traffic control signal devices, barricades, signs and other Control Devices shall be either new or in acceptable condition when first erected on Project and shall remain in acceptable condition throughout the construction period.
- C. All signs shall have a black legend and border on an orange reflectorized background and will be a minimum of engineering grade reflective.

PART 3 – EXECUTION

3.1 ERECTION

- A. Prior to commencement of any actual construction on the project, Contractor shall erect appropriate advance warning signs and place concrete traffic barriers where necessary. Subsequently, as construction progresses and shifts from one side of road to the other, temporary lanes must be installed to provide continuous two way traffic and bike thoroughfare. All appropriate signs and traffic control devices pertinent to the work shall be erected ahead of construction site to advise and warn travelling public of activity and any necessary detours.

3.2 DELAYS TO TRAFFIC

- A. Except in rare and unusual circumstances, two-way traffic shall be maintained at all times by temporary and/or permanent roads. There are to be no traffic delays during the hours between 7 AM – 10 AM and 4 PM – 10 PM. Between the hours of 10 AM and 4 PM the maximum delay is to be 15-minutes.
- B. When traffic is halted temporarily due to transition procedures including the ingress and egress of construction vehicles, Contractor shall provide necessary flagging personnel with proper equipment and clothing to hold such traffic.
- C. If Contractor's proposed traffic control plan involves more than occasional disruption to alternating one way traffic through the work, then temporary, signalized control equipment will be required.

3.3 TEMPORARY TRAFFIC LANES

- A. Two-lane traffic shall be maintained at all times unless prior written permission has been given and all necessary flagging personnel and/or signage has been installed. Temporary lane line stripes shall be applied to the detour paving, as agreed to by Engineer and Owner's representative. The no-passing double center-line stripes shall be yellow. Such stripes shall be a temporary, degradable, reflectorized tape strip. All temporary striping shall be maintained throughout the period traffic control is needed.
- B. Contractor is responsible for installation and removal of all temporary roads and trails throughout the construction process. These detour roads are to be in accordance with the Pavement Specifications herein.

3.4 SIGNS AND BARRICADES

- A. Contractor shall provide a detailed map showing location and verbage of all traffic control signs and methods for the project. All critical warning signs for the project will be a minimum of engineering grade reflective material and include appropriate flashing lights.
- B. Appropriate Safety Barricades shall be installed between bicycle trails, sidewalks, and the temporary traffic lanes. These barricades shall be impact resistant for passenger vehicles with a travelling speed of 40 mph.

1. Advance warning signs: These signs shall be placed approximately 500 feet in advance of the construction site and detour on each approach to the construction area with subsequent warning signs every 250 feet, until construction site is met.
2. Road Construction Signs: Before and during construction of the detour, advance road construction signs shall be located as already stated above. The construction site detour lanes will have reflective trestle type barricade with flashing lights spaced a maximum of 25 feet apart to delineate each side of any temporary roadway. Additional signage shall be placed to indicate a reduced speed limit of 10 mph or the speed limit set by the City Traffic Engineering Department for the entire construction area. Other signs as appropriate to a particular activity in the work area shall be erected in advance of that activity.
3. Barricades: While detour is open to traffic, a line of concrete traffic barricades shall be placed across the closed roadway to channelize traffic onto detour. They shall be spaced across the blocked roadway end to end so no vehicle will be able to pass between any two adjacent barricades.
4. Barriers: Shall be wooden having a minimum of 3 horizontal 6 inch rails spaced 20 inches on center. Markings for barrier rails shall be 6 inches wide alternate orange and white reflectorized stripes sloping downward at 45 degrees in the direction traffic is to pass.

During hours of darkness, the Contractor shall place and maintain flashing warning lights on tops of all barriers.

5. Direction Arrow Signs: At each change in traffic direction along the detour, Contractor shall install a sign with an arrow indicating change in traffic direction. This sign is to be located across the pavement from and facing on-coming traffic.
6. End Construction Sign: This sign shall be 60 inches x 24 inches and erected approximately 200 feet beyond end of construction area on the right-hand side.

END OF SECTION

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EXTRUDED OR HOT SPRAY APPLICATION

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SECTION 02580**THERMOPLASTIC PAVEMENT MARKINGS
EXTRUDED OR HOT SPRAY APPLICATION****PART 1 – GENERAL****1.1 DESCRIPTION:**

- A. Work shall consist of furnishing and applying thermoplastic reflectorized pavement marking materials on surface of pavements to provide pavement markings of a color (white or yellow) and pattern as indicated on the construction drawings. Contractor shall supply all necessary equipment and materials for the installation of traffic markings.

1.2 WARRANTY:

- A. Contractor shall transfer warranty to the Owner on thermoplastic materials issued by manufacturer. Contractor shall also furnish the Owner a 12-month warranty for application. These warranties shall specify guaranteed retainage of material for a stated period beginning with the application date. Work will not be allowed to commence until warranties have been received by the Owner.

PART 2 – PRODUCTS**2.1 MATERIALS:**

- A. Pavement marking material shall be a reflectorized mixture of thermoplastic binder and reflectorized glass beads. Additional glass beads are applied by dropping immediately after marking material is applied to surface of the pavement. Prior to application of the pavement marking material, surface of all pavements shall be coated with a primer-sealer material if recommended by thermoplastic manufacturer.
- B. Thermoplastic Compound: The hydrocarbon type thermoplastic compound shall meet all requirements of AASHTO M 249. Except material may be shipped in the granulated form.
- C. Glass Beads – (Drop-on): The drop-on glass beads shall meet requirements of AASHTO M 247 – Type 1.
- D. Primer-Sealer – A primer-sealer as recommended by the manufacturer of thermoplastic pavement marking material shall be utilized on all portland cement pavement surfaces and all bridge surfaces which have not been overlaid with asphalt. Primer-sealer also shall be utilized on any type of pavement prior to the placing of Railroad Crossing Symbols. Primer-sealer shall be used on asphaltic concrete pavement surfaces if recommended by the manufacturer of thermoplastic pavement marking material. Primer-sealer shall form a continuous film which will mechanically adhere to pavement and shall not discolor nor cause

any noticeable change in appearance of the pavement outside of finished pavement marking.

- E. Contractor shall obtain from manufacturer of the thermoplastic binder, tests results required by AASHTO M 249 for each batch of material furnished along with a final certification stating materials furnished met requirements of contract specifications. Contractor shall obtain from manufacturer of drop-on glass beads a certification stating material furnished met requirements of contract specifications. Copies of above described affidavits shall be furnished to the Owner.

PART 3 – EXECUTION

3.1 APPLICATION PROPERTIES OF AASHTO M 249 IS EXPANDED AS FOLLOWS:

- A. Equipment – Material shall be prepared by only means of an insulated batching machine recommended or furnished by manufacturer of compound and shall consist of a special kettle for melting and heating the composition. Applicators may be either a truck mounted liner or a portable unit. "Truck mounted" shall be defined as a self-propelled vehicle with six or more wheels and an enclosed cab for housing the driver.

If contract requires extruded application, material shall be applied to the pavement by an extrusion method wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of suitable equipment for heating and controlling the flow of the material.

The batching machine shall be constructed to provide continuous mixing and agitation of material. Conveying part of equipment between the main material reservoir and final dispensing nozzle/shaping die shall be constructed to prevent accumulation and clogging. All parts of equipment which come in contact with the material shall be constructed to be easily accessible and exposable for cleaning and maintaining.

Equipment shall be constructed so all mixing and conveying parts to final dispensing nozzle/shaping die maintain material at the plastic temperature.

Equipment shall be constructed to assure continuous uniformity in dimensions of the markings.

Controls shall be set up so the operator can override set automatic cycles in order to extend a line or to begin a new cycle at any selected point.

Applicators shall provide a means for cleanly cutting off square stripe ends. Truck mounted liner shall provide a method of automatically applying "skip" or solid longitudinal lines, including right and left edge lines, of any combination of single or double line configurations (color and pattern) with machine traveling in the direction of normal traffic flow. The use of pans, aprons, or similar appliance which the nozzle/die overruns will not be permitted.

Beads shall be applied to surface of completed stripe by an automatic bead dispenser attached to the applicator. Beads are dispensed almost instantly upon the completed line.

Applicators shall be constructed to produce varying widths of traffic markings as indicated on construction drawings.

Heating of kettles and melters shall be by controlled heat transfer systems which are oil jacketed or indirect flame air jacketed. Directed flame equipment will not be allowed. All kettles and melters must be equipped with an automatic thermostatic control device and proper thermometers to control temperature of the material at manufacturer's recommended application temperature range.

Applicator and kettle must be so equipped and arranged as to satisfy requirements of the National Fire Underwriters, and all state and local requirements.

Applicators shall be mobile and maneuverable so straight lines can be followed and normal curves can be made.

B. Construction Requirements – Traffic shall not be permitted through the project during construction.

1. Preparation of Surface – The pavement shall be dry and free of glaze, oil, dirt, grease or other foreign contaminants. Where directed by Engineer, Contractor shall buff or sand blast pavement surface for a width equal to two inches wider than the stripe to be applied in order to secure a proper surface for adequate bonding of thermoplastic material.
2. Application of Primer–Sealer – Where used, primer–sealer shall be sprayed on the pavement surface where the lines are to be applied. Thickness of application and time on the pavement prior to thermoplastic application shall be governed by recommendations of primer–sealer manufacturer.
3. Application of Marking Material – All longitudinal markings shall be placed with a truck–mounted applicator except where the length of a particular marking is too short, or curvature too great, to permit efficient use of the liner. Transverse markings may be applied with a portable unit.

The markings shall be straight or of uniform curvature and shall conform uniformly with tangents, curves and transitions. Symbols shall be of dimensions shown on the plans. Markings must be of dimensions and placed as shown on the plans. The contractor shall provide sufficient control points to serve as guides for application of markings.

Finished line markings shall be free from waviness and the lateral deviation shall not exceed two (2) inches in fifteen (15) feet. Any greater deviation shall be sufficient cause for requiring the Contractor to remove and correct such markings at their own expense. Contractor shall also be required to remove and correct any symbol markings not meeting dimensional requirement shown on the plans.

Contractor shall protect the markings until dry by placing guarding or warning devices as necessary. In the event any vehicle should cross a wet marking, such marking shall be reapplied and lines made by moving vehicle removed by Contractor.

To avoid poor quality marks, markings are to be placed only when surface of pavement is dry as determined by visual inspection, when the relative humidity as reported by local weather authorities is 90% or less, and when the pavement surface temperature, as determined by means of surface thermometers, is 55 degrees F or above. Contractor shall provide appropriate surface thermometers, certified to be correct, to measure pavement temperatures during the work.

No markings shall be applied between October 15 and March 1 inclusive, except by permission of the Engineer.

Sufficient personnel experienced in handling and application of this type of material shall be provided by Contractor to assure work is completed properly.

Work shall be completed only during daylight hours, and all markings shall be sufficiently dry, before sunset, to permit crossing by traffic. All protective devices shall be removed before sunset to allow free movement of traffic at night.

Marking material shall be applied at a temperature providing best adhesion to the pavement and shall be between 380 degrees F and 420 degrees F or as recommended by the manufacturer. The material shall be heated uniformly throughout and shall have uniform disbursement of binder, pigment, and glass beads when applied to surface of the pavement.

All extruded lines 12 inches or less shall be applied with a die equal to the width of the line. All lines greater than 12 inches may be applied with two dies, the total widths of which equal the width of the line.

4. Rate of Application

- a. Marking material shall be applied at the specified widths and at a rate to result in a new material thickness at center of line as specified below.

5. Type of Marking

- a. Edge lines and median lines (5" solid white, 5" solid yellow and 5" broken yellow). 90 mils

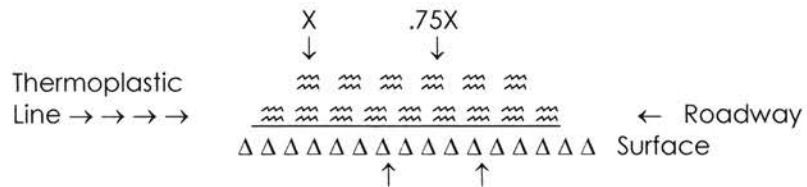
Lane lines (5" broken white) 90 mils

Center lines on two – lane roadways (5" broken yellow and 5" solid yellow) 90 mils

- b. All others 125 mils

The diagram below refers to applications of all thicknesses.

The edge of the line shall be not thinner than 75% of the center thickness.



NO SCALE

- c. Glass Beads – “Drop-on” glass beads shall be mechanically applied to surface of marking material immediately after material is applied to the pavement surface, and while marking material is still molten so beads will be held by and mechanically embedded in surface of material. Beads shall be uniformly distributed over the minimum rate of 12 pounds per 100 square feet of stripe. Drop-on beads shall be applied mechanically.

3.2 OBSERVATION AND ACCEPTANCE OF WORK:

- A. All thermoplastic markings shall be checked both day and night to determine whether the intent of these specifications has been achieved. Any markings failing to have satisfactory appearance, either day or night, shall be reapplied at Contractor's expense.

Final acceptance of thermoplastic pavement markings will be delayed for a period of 30 days after completion to permit observation of performance. Contractor shall be required to replace any markings or markers that, in the opinion of Owner, have not performed satisfactorily during this 30-day period due to defective materials and workmanship in manufacture and application.

Application of Pavement Markings and Non-recessed Pavement Markers – When pavement markings (centerline, lane lines, and edge lines) and non-recessed pavement markers are applied on a roadway opened to traffic and in a continuous operation of moving vehicles and equipment, the following minimum warning devices shall be required.

1. The vehicle applying the pavement markings shall have sequential or flashing arrows as directed by Engineer.
2. A shadow vehicle shall maintain at least a distance of 50' behind the vehicle applying pavement markings and shall have an acceptable sequential or flashing arrow board.

Application of pavement markings shall be accomplished without stopping traffic except when directed by the Owner. If Owner allows temporary closing of any

part of the traveled width of any pavement, either on main roadway or intersecting roads and drives, and thereby restrict traffic, Contractor shall provide all barricades, lights, flagmen and such other protection to traffic as may be necessary for protection of work and safety of public.

Contractor shall at all times set up and operate equipment to encroach as little as possible upon the traveled width of any pavement opened to traffic.

Contractor shall submit a traffic control plan for application of thermoplastics. The plan will have to be reviewed and accepted by Owner before work begins.

END OF SECTION.

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FUSIBLE POLYVINYLCHLORIDE PIPE FOR
INSTALLATION BY HORIZONTAL DIRECTIONAL DRILLING (HDD)

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SECTION 02610

FUSIBLE POLYVINYLCHLORIDE PIPE FOR INSTALLATION BY HORIZONTAL DIRECTIONAL DRILLING (HDD)

PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE:

1. This section specifies fusible polyvinylchloride pipe, including standards for dimensionality, testing, quality, acceptable fusion practice, safe handling, storage, and installation of the pipe by horizontal directional drilling, directional boring, or guided boring.

B. REQUIREMENTS:

1. Contractor shall provide fusible polyvinylchloride pipe conforming to all standards and procedures, and meeting all testing and material properties as described in this specification for installation by horizontal directional drilling.
2. Contractor shall be responsible for all installation processes and procedures associated with the installation by horizontal directional drilling in accordance with this specification.

C. PIPE DESCRIPTION:

1. Pipe Supplier shall furnish fusible polyvinylchloride pipe conforming to all standards and procedures, and meeting all testing and material properties as described in this specification.
2. Pipe shall conform to the following dimensionality and general characteristics table:

[CHOOSE THE REQUIRED PIPES FROM THE TABLE BELOW]

Pipe Description	Nominal Diameter (inches)	DR	Color	Pressure Class (psi)	Required Inner Diameter (inches)
Water Main – FPVC	24"	18	Blue	235	22.76
Water Main – FPVC	20"	18	Blue	200	20
Water Main – FPVC	20"	18	Blue	235	19.06
Water Main – FPVC	16"	18	Blue	235	15.466
Water Main – FPVC	16"	14	Blue	305	14.76
Water Main – FPVC	12"	18	Blue	235	11.65
Water Main – FPVC	6"	18	Blue	235	6.09
Water Main – FPVC	4"	18	Blue	235	4.23
Force Main – FPVC	12"	18	Green	235	11.65
Force Main – FPVC	10"	18	Green	235	9.79

Force Main – FPVC	8"	18	Green	235	7.98
Force Main – FPVC	6"	18	Green	235	6.08
Force Main – FPVC	4"	18	Green	235	4.23

1.2 QUALITY ASSURANCE

A. REFERENCES:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those other standards are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of design, bid, or construction, whichever is earliest. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ANSI/AWWA C110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids
ANSI/AWWA C111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C605	Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C651	Standard for Disinfecting Water Mains
AWWA C900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100mm Through 300mm), for Water Distribution
AWWA C905	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350mm Through 1200mm), for Water Distribution and Transmission
AWWA M23	AWWA Manual of Supply Practices PVC Pipe—Design and Installation, Second Edition
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

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Reference	Title
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 Test Method for Degree of Fusion of Extruded
ASTM D2152	Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F1057	Standard Practice for Estimating the Quality of Extruded Poly (Vinyl Chloride) (PVC) Pipe by the Heat Reversion Technique
ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
UNI-B-6	Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
UNI-PUB-08	Tapping Guide for PVC Pressure Pipe
NSF-14	Plastics Piping System Components and Related Materials
NSF-61	Drinking Water System Components—Health Effects
PPI TR-2	PVC Range Composition Listing of Qualified Ingredients

B. MANUFACTURER REQUIREMENTS

1. All piping shall be made from PVC compound conforming to cell classification 12454 per ASTM D1784.

C. FUSION TECHNICIAN REQUIREMENTS

1. Fusion Technician shall be fully qualified by the pipe supplier to install fusible polyvinylchloride pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.

D. SPECIFIED PIPE SUPPLIERS

1. Fusible polyvinylchloride pipe shall be equivalent to those manufactured under the trade names Fusible C-900®, Fusible C-905®, and FPVC®, for Underground Solutions, Inc., Poway, CA, (858) 679-9551. Fusion process shall be equivalent to the process as patented by Underground Solutions, Inc., Poway, CA, Patent No. 6,982,051. No other supplier of fusible polyvinylchloride pipe shall be used unless accepted in writing by Owner/Engineer.

E. WARRANTY

1. The pipe shall be warranted for one year per the pipe supplier's standard 02610-3

terms.

2. In addition to the standard pipe warranty, the fusion services shall be warranted for one year per the fusion service provider's standard terms.

F. PRE-CONSTRUCTION SUBMITTALS

1. The following PRODUCT DATA is required from the pipe supplier and/or fusion provider:
 - a. Pipe Size
 - b. Dimensionality
 - c. Pressure Class per applicable standard
 - d. Color
 - e. Recommended Minimum Bending Radius
 - f. Recommended Maximum Safe Pull Force
 - g. Fusion technician qualification indicating conformance with this specification
2. The following WORK PLAN AND INFORMATION is required from the contractor and/or horizontal directional drilling Contractor. This WORK PLAN AND INFORMATION shall also be supplied to the pipe supplier, should it be requested:
 - a. Work plan shall include for each HDD installation any excavation locations and dimensions, interfering utilities, bore dimensions and locations including bend radii used, and traffic control schematics.
 - b. A project safety and contingency plan which shall include but shall not be limited to drilling fluid containment and cleanup procedures, equipment and plan for compromised utility installations including electrical and power lines, water, wastewater and any other subsurface utility in the area.
 - c. An HDD schedule identifying daily work hours and working dates for each installation.

G. POST-CONSTRUCTION SUBMITTALS

1. The following AS-RECORDED DATA is required from the contractor and/or fusion provider to the owner or pipe supplier upon request:
 - a. Approved datalogger device reports
 - b. Fusion joint documentation containing the following information:
 - i. Pipe Size and Thickness
 - ii. Machine Size
 - iii. Fusion Technician Identification
 - iv. Job Identification
 - v. Fusion Joint Number
 - vi. Fusion, Heating, and Drag Pressure Settings
 - vii. Heat Plate Temperature

- viii. Time Stamp
- ix. Heating and Cool Down Time of Fusion
- x. Ambient Temperature
- c. As-recorded Information
 - i. The as-recorded plan and profile will reflect the actual installed alignment, and reflect the horizontal offset from the baseline and depth of cover.
 - ii. All fittings, valves, or other appurtenances will also be referenced and shown.
 - iii. A daily project log, along with tracking log sheets, should they be used, shall be provided. Tracking log sheet data, should it be employed, shall include any and all that apply, including inclination, depth, azimuth, and hydraulic pull-back and rotational force measured.

PART 2 – PRODUCTS

2.1 FUSIBLE POLYVINYLCHLORIDE PRESSURE PIPE FOR WASTEWATER

- A. Fusible polyvinylchloride pipe shall conform to AWWA C900, AWWA C905, ASTM D2241 or ASTM D1785 for standard dimensionality, as applicable. Testing shall be in accordance with the referenced AWWA standards.
- B. Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- C. Fusible polyvinylchloride pipe shall be manufactured in a standard 40' nominal length, or custom lengths as specified.
- D. Fusible polyvinylchloride pipe shall be green in color for wastewater use.
- E. Pipe generally shall be marked to include as a minimum:
 - 1. Nominal pipe size
 - 2. PVC
 - 3. Dimension Ratio, Standard Dimension Ratio, or Schedule
 - 4. Pressure class or standard pressure rating
 - 5. Standard designation number or pipe type
 - 6. Extrusion production-record code
 - 7. Trademark or trade name
 - 8. Cell Classification 12454 and/or PVC material code 1120 may also be included
- F. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

2.2 OMITTED

2.3 OMITTED

2.4 FUSION JOINTS

- A. Unless otherwise specified, fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier's written guidelines for this procedure. All fusion joints shall be completed as described in this specification.

2.5 CONNECTIONS AND FITTINGS FOR PRESSURE APPLICATIONS

- A. Connections shall be defined in conjunction with the coupling of project piping, as well as the tie-ins to other piping systems.

B. DUCTILE IRON MECHANICAL AND FLANGED FITTINGS

Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard ductile iron fittings conforming to AWWA/ANSI C110/A21.10 and AWWA/ANSI C111/A21.11.

1. Connections to fusible polyvinylchloride pipe may be made using a restrained or non-restrained retainer gland product for PVC pipe, as well as for MJ or flanged fittings.
2. Bends, tees, and other ductile iron fittings shall be restrained with the use of thrust blocking or other means as indicated in the construction documents.
3. Ductile iron fittings and glands must be installed per the manufacturer's guidelines.

C. PVC GASKETED, PUSH-ON FITTINGS

Acceptable fittings for use with fusible polyvinylchloride pipe shall include standard PVC pressure fittings conforming to AWWA C900 or AWWA C905.

1. Acceptable fittings for use joining fusible polyvinylchloride pipe other sections of fusible polyvinylchloride pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings and fittings, including bends, tees, and couplings as shown in the drawings.
2. Bends, tees, and other PVC fittings shall be restrained with the use of thrust blocking or other restraint products as indicated in the construction documents.
3. PVC gasketed, push-on fittings, and mechanical restraints, if used, must be installed per the manufacturer's guidelines.

D. FUSIBLE POLYVINYL CHLORIDE SWEEPS OR BENDS

1. Fusible polyvinyl chloride sweeps or bends shall conform to the same sizing convention, diameter, dimensional tolerances and pressure class of the pipe being joined using the sweep or bend.
2. Fusible polyvinyl chloride sweeps or bends shall be manufactured from the same fusible polyvinyl chloride pipe being used for the installation, and shall have at least 2 feet of straight section on either end of the sweep or bend to allow for fusion of the sweep to the pipe installation. There shall be no gasketed connections utilized with a fusible polyvinyl chloride

sweep.

3. Standard fusible polyvinyl chloride sweep or bend angles shall not be greater than 22.5 degrees, and shall be used in nominal diameters ranging from 4 inch through 16 inch.

E. SLEEVE-TYPE COUPLINGS

1. Sleeve-type mechanical couplings shall be manufactured for use with PVC pressure pipe, and may be restrained or unrestrained as indicated in the construction documents.
2. Sleeve-type couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.

F. EXPANSION AND FLEXIBLE COUPLINGS

1. Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as indicated in the construction documents.
2. Expansion-type mechanical couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.

G. CONNECTION HARDWARE

Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21.11, regardless of any other protective coating.

2.6 DRILLING SYSTEM EQUIPMENT

A. GENERAL

1. The directional drilling equipment, as a minimum, shall consist of a directional drilling rig of sufficient capacity to perform the bore(s) and pull-back of the pipe(s), a drilling fluid mixing & delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project. All required equipment shall be included in the emergency and contingency plan as submitted per these specifications.

B. DRILLING RIG

1. The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull drill pipe while delivering a pressurized fluid mixture to a drill head. The machine shall be anchored to withstand the pulling, pushing and rotating forces required to complete the project.
2. The drilling rig hydraulic system shall be of sufficient pressure and volume to power drilling operations. The hydraulic system shall be free from leaks.
3. The drilling rig shall have a system to monitor pull-back hydraulic pressure during pull-back operations.

C. DRILL HEAD

1. The horizontal directional drilling equipment shall produce a stable fluid

lined tunnel with the use of a steer-able drill head and any subsequent pre-reaming heads.

2. The system must be able to control the depth and direction of the drilling operation.
3. Drill head shall contain all necessary cutters and fluid jets for the operation, and shall be of the appropriate design for the ground medium being drilled.

D. DRILLING FLUID SYSTEM

1. DRILLING FLUID (DRILLING MUD)

- a. Drilling fluid shall be composed of clean water and the appropriate additive(s) for the fluid to be used. Water shall be from a clean source and shall meet the mixing requirements of the mixture manufacturer(s).
- b. The water and additives shall be mixed thoroughly to assure the absence of any clumps or clods. No hazardous additives may be used.
- c. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall(s).
- d. Drilling fluid shall be disposed of off-site in accordance with local, state and federal requirements and/or permit conditions.
- e. No additional chemicals or polymer surfactants shall be allowed to be added to the drilling fluid unless they have been submitted per this specification.

2. MIXING SYSTEM

- a. A drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid for the project.
- b. The mixing system shall be able to ensure thorough mixing of the drilling fluid. The drilling fluid reservoir tank shall be sized for adequate storage of the fluid.
- c. The mixing system shall continually agitate the drilling fluid during drilling operations.

3. DRILLING FLUID DELIVERY AND RECOVERY SYSTEM

- a. The drilling fluid pumping system shall have a minimum capacity to supply drilling fluid in accordance with the drilling equipment pull-back rating at a constant required pressure.
- b. The delivery system shall have filters or other appropriate in-line equipment to prevent solids from being pumped into the drill pipe.
- c. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of. The use of spill containment measures shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps, vacuum truck(s), and/or storage of sufficient size shall be in place to contain excess drilling fluid.

- d. A closed-loop drilling fluid system and a drilling fluid cleaning system should be used to whatever extent practical, depending upon project size and conditions. Under no circumstances shall drilling fluid that has escaped containment be reused in the drilling system.
- E. DRILLING CONTROL SYSTEM
- 1. Calibration of the electronic detection and control system shall be verified prior to the start of the bore.
 - 2. The drilling head shall be remotely steer-able by means of an electronic or magnetic detection system. The drilling head location shall be monitored in three dimensions:
 - a. Offset from the baseline,
 - b. Distance along the baseline, and
 - c. Depth of cover.
 - 3. Point of rotation of the head shall also be monitored.
 - 4. For gravity application and on-grade drilling, sonde/beacon or approved equipment applicable for grade increments of 1/10th of one percent shall be used.

2.7 PIPE PULL HEADS

- A. Pipe pull heads shall be utilized that employ a positive through-bolt design assuring a smooth wall against the pipe cross-section at all times.
- B. Pipe pull heads shall be specifically designed for use with fusible polyvinylchloride pipe, and shall be as recommended by the pipe supplier.

2.8 PIPE ROLLERS

- A. Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe during handling and pullback operations.
- B. A sufficient quantity of rollers and spacing, per the pipe supplier's guidelines shall be used to assure adequate support and excessive sagging of the product pipe.

PART 3 – EXECUTION

3.1 DELIVERY AND OFF-LOADING

- A. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Engineer.
- B. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify [Owner] [or] [Engineer] immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color, and type.
- C. Pipe should be loaded, off-loaded, and otherwise handled in accordance with

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AWWA M23, and all of the pipe supplier's guidelines shall be followed.

- D. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- E. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- F. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.

3.2 HANDLING AND STORAGE

- A. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the owner or engineer.
- B. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Engineer.
- C. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.
- D. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way.
- E. If pipe is to be stored for periods of 1 year or longer, the pipe should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
- F. Pipe shall be stored and stacked per the pipe supplier's guidelines.

3.3 FUSION PROCESS

- A. GENERAL
 - 1. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.
 - 2. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.
 - 3. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
 - 4. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion

machines must incorporate the following elements:

- a. HEAT PLATE – Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be cap
 - b. able of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.
 - c. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
 - d. GENERAL MACHINE – Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.
 - e. DATA LOGGING DEVICE – An approved datalogging device with the current version of the pipe supplier's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
5. Other equipment specifically required for the fusion process shall include the following:
- a. Pipe rollers shall be used for support of pipe to either side of the machine
 - b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
 - c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
 - d. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
 - e. Facing blades specifically designed for cutting fusible polyvinylchloride pipe shall be used.

B. JOINT RECORDING

Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

3.4 DRILLING OPERATIONS

A. GENERAL

1. Bore path and alignment are as indicated in the contract documents. The path of the bore may be modified based on field and equipment conditions. Entry and exit locations and control-point elevations shall be maintained as indicated in the contract documents.
2. Bend radii shown in the contract documents are minimum allowable radii and shall not be reduced.

B. LOCATION AND PROTECTION OF UNDERGROUND UTILITIES

1. Correct location of all underground utilities that may impact the HDD installation is the responsibility of the Contractor, regardless of any locations shown on the drawings or previous surveys completed.
2. Utility location and notification services shall be contacted by the Contractor prior to the start of construction.
3. All existing lines and underground utilities shall be positively identified, including exposing those facilities that are located within an envelope of possible impact of HDD installation as determined for the project specific site conditions. It is the Contractor and HDD system operator's responsibility to determine this envelope of safe offset from existing utilities. This will include, but is not limited to, soil conditions and layering, utility proximity and material, HDD system and equipment, and foreign subsurface material.

C. SITE LOCATION PREPARATION

1. Work site as indicated on drawings shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made
2. Contractor shall confine all activities to designated work areas.

D. DRILLING LAYOUT AND TOLERANCES

1. The drill path shall be accurately surveyed with entry and exit areas placed in the appropriate locations within the areas indicated on drawings. If using a magnetic guidance system, drill path will be surveyed for any surface geomagnetic variations or anomalies.
2. Instrumentation shall be provided and maintained at all times that accurately locates the pilot hole, measures drill-string axial and torsional loads and measures drilling fluid discharge rate and pressure.
3. Entry and exit areas shall be drilled so as not to exceed the bending limitations of the pipe as recommended by the pipe supplier.

E. PILOT HOLE BORE

1. Pilot hole shall be drilled along bore path. In the event that the pilot bore does deviate from the bore path, it may require contractor to pull-back and re-drill from the location along bore path before the deviation.
2. The Contractor shall limit curvature in any direction to reduce force on the pipe during pull-back. The minimum radius of curvature shall be no less

than that specified by the pipe supplier and as indicated on the drawings.

F. REAMING

1. After successfully completing the pilot hole, the bore hole shall be reamed to a diameter which meets the requirements of the pipe being installed. The following table is offered as an estimated guide:

Nominal Pipe Diameter	Bore Hole Diameter
< 8 inches	Pipe Dia. + 4 inches
8 inches to 24 inches	Pipe Dia. X 1.5
> 24 inches	Pipe Dia. + 12 inches

2. Multiple reaming passes shall be used at the discretion of the Contractor and shall conform to this specification.
3. In the event of a drilling fluid fracture, returns loss or other loss of drilling fluid, the Contractor shall be responsible for restoring any damaged property to original condition and cleaning up the area in the vicinity of the damage or loss.

3.5 PIPE PULL-BACK AND INSERTION

- A. Pipe shall be fused prior to insertion, if the site and conditions allow, into one continuous length.
- B. Contractor shall handle the pipe in a manner that will not over-stress the pipe prior to insertion. Vertical and horizontal curves shall be limited so that the pipe does not bend past the pipe supplier's minimum allowable bend radius, buckle, or otherwise become damaged. Damaged portions of the pipe shall be removed and replaced.
- C. The pipe entry area shall be graded as needed to provide support for the pipe and to allow free movement into the bore hole.
 1. The pipe shall be guided into the bore hole to avoid deformation of, or damage to, the pipe.
 2. The fusible polyvinylchloride pipe may be continuously or partially supported on rollers or other Owner and Engineer approved friction decreasing implement during joining and insertion, as long as the pipe is not over-stressed or critically abraded prior to, or during installation.
 3. A swivel shall be used between the reaming head and the fusible polyvinylchloride pipe to minimize torsion stress on the pipe assembly.
- D. Buoyancy modification shall be at the sole discretion of the Contractor, and shall not exceed the pipe supplier's guidelines in regards to maximum pull force or minimum bend radius of the pipe. Damage caused by buoyancy modifications shall be the responsibility of the Contractor.
- E. Once pull-back operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole.
- F. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, or movement and distortion of surface features. Any damages caused

by the Contractor's operations shall be corrected by the Contractor.

3.6 INSTALLATION CLEANUP

- A. Following the installation, the project site shall be returned to a condition equal to or better than the pre-construction condition of the site. All excavations will be backfilled and compacted per the construction documents and jurisdictional standards. All pavement and hardscape shall be repaired per applicable jurisdictional standards, excess materials shall be removed from the site, and disturbed areas shall be re-landscaped. All drilling fluid shall be properly disposed of per these specifications and all applicable jurisdictional laws.
- B. Contractor shall verify that all utilities, structures, and surface features in the project area are sound.

3.7 PREPARATION PRIOR TO MAKING CONNECTIONS INTO EXISTING PIPING SYSTEMS

- A. Approximate locations for existing piping systems are shown in the construction documents. Prior to making connections into existing piping systems, the contractor shall:
 - 1. Field verify location, size, piping material, and piping system of the existing pipe.
 - 2. Obtain all required fittings, which may include saddles, sleeve type couplings, flanges, tees, or others as shown in the construction documents.
 - 3. Have installed all temporary pumps and/or pipes in accordance with established connection plans.
- B. Unless otherwise approved, new piping systems shall be completely assembled and successfully tested prior to making connections into existing pipe systems.

3.8 PIPE SYSTEM CONNECTIONS

- A. Pipe connections shall be installed per applicable standards and regulations, as well as per the connection manufacturer's guidelines and as indicated in the construction documents. Pipe connections to structures shall be installed per applicable standards and regulations, as well as per the connection manufacturer's guidelines.
- B. If possible, pipe installed via HDD shall be filled with water prior to making any connections to the existing system or other portions of the project.

3.9 TAPPING FOR POTABLE AND NON-POTABLE WATER APPLICATIONS

- A. Tapping shall be performed using standard tapping saddles designed for use on PVC piping in accordance with AWWA C605. Tapping shall be performed only with use of tap saddles or sleeves. NO DIRECT TAPPING WILL BE PERMITTED. Tapping shall be performed in accordance with the applicable sections for Saddle Tapping per Uni-Pub-8.
- B. All connections requiring a larger diameter than that recommended by the pipe supplier, shall be made with a pipe connection as specified and indicated on the drawings.

- C. Equipment used for tapping shall be made specifically for tapping PVC pipe:
 - 1. Tapping bits shall be slotted "shell" style cutters, specifically made for PVC pipe. 'Hole saws' made for cutting wood, steel, ductile iron, or other materials are strictly prohibited.
 - 2. Manually operated or power operated drilling machines may be used.
- D. Taps may be performed while the pipeline is filled with water and under pressure ('wet' tap,) or when the pipeline is not filled with water and not under pressure ('dry' tap).

3.10 TESTING

- A. Testing shall comply with all applicable jurisdictional building codes, statutes, standards, regulations, and laws.
- B. HYDROSTATIC TESTING AND LEAKAGE TESTING FOR PRESSURE PIPING
 - 1. Hydrostatic and leakage testing for piping systems that contain mechanical jointing as well as fused PVC jointing shall comply with AWWA C605.
 - 2. Unless agreed to or otherwise designated by the owner or engineer, for a simultaneous hydrostatic and leakage test following installation, a pressure equal to 150 psi shall be applied. The duration of the pressure test shall be for two (2) hours.
 - 3. If hydrostatic testing and leakage testing are performed at separate times, follow procedures as outlined in AWWA C605.
 - 4. In preparation for pressure testing the following parameters must be followed:
 - a. All air must be vented from the pipeline prior to pressurization. This may be accomplished with the use of the air relief valves or corporation stop valves, vent piping in the testing hardware or end caps, or any other method which adequately allows air to escape the pipeline at all high points. Venting may also be accomplished by 'flushing' the pipeline in accordance with the parameters and procedures as described in AWWA C605.
 - b. The pipeline must be fully restrained prior to pressurization. This includes complete installation of all mechanical restraints per the restraint manufacturer's guidelines, whether permanent or temporary to the final installation. This also includes the installation and curing of any and all required thrust blocking. All appurtenances included in the pressure test, including valves, blow-offs, and air-relief valves shall be checked for proper installation and restraint prior to beginning the test.
 - c. Temporary pipeline alignments that are being tested, such as those that are partially installed in their permanent location shall be configured to minimize the amount of potentially trapped air in the pipeline.
- C. DISINFECTION OF THE PIPELINE FOR POTABLE WATER PIPING
 - 1. After installation, the pipeline, having passed all required testing, shall be

disinfected prior to being put into service. Unless otherwise directed by the owner or engineer, the pipeline will be disinfected per AWWA C651.

D. PARTIAL TESTING

1. Segments of the pipe may be tested separately in accordance with standard testing procedure, as approved by the owner and engineer. Testing of each HDD installation prior to connection to the system or other piping is preferred.

END OF SECTION

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SECTION 02831 – CHAIN LINK FENCES AND GATES

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SECTION 02831**CHAIN LINK FENCES AND GATES****PART 1 – GENERAL****1.1 SECTION INCLUDES**

- A. Fence framework, fabric, and accessories.
- B. Excavation for post bases; concrete foundation for posts, and center drop for gates.
- C. Manual gates and related hardware.

1.2 RELATED SECTIONS

- A. Section 02551 – Distribution Pump Station.

1.3 MEASUREMENT AND PAYMENT

- A. Pump Station Site Fencing and Gates: Payment for chain-link fence, complete, will be included in the lump sum price for "Site Work."

1.4 REFERENCES

- A. ASTM A 90/A 90M-01 – Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- B. ASTM A 116-00 – Metallic-Coated, Steel Woven Wire Fence Fabric.
- C. ASTM A 121-99 – Zinc-Coated (Galvanized) Steel Barbed Wire.
- D. ASTM A 123/A 123M-00 – Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- E. ASTM A 153/A 153M-00 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- F. ASTM A 392-96 – Zinc-Coated Steel Chain-Link Fence Fabric.
- G. ASTM A 1011-01 – Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.
- H. ASTM A 653/A 653M-00 – Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A 491-96 – Aluminum-Coated Steel Chain-Link Fence Fabric.
- J. ASTM F 668-99a – Poly (Vinyl Chloride) (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.

- K. ASTM A 585-97 – Aluminum-Coated Steel Barbed Wire.
- L. ASTM A 428/A 428M-01 – Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles.
- M. ASTM C 94/C 94M-00e1 – Ready-Mixed Concrete.
- N. ASTM F 567-00 – Installation of Chain-Link Fence.
- O. ASTM F 1043-00 – Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
- P. ASTM F 1083-97 – Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- Q. Chain Link Fence Manufacturers Institute (CLFMI) – Product Manual.

1.5 SYSTEM DESCRIPTION

- A. Fence Height: 6 feet nominal.
- B. Line Post Spacing: At intervals not exceeding 10 feet.
- C. Fence Post and Rail Strength: Conform to ASTM F1043 Light Industrial Fence quality.

1.6 SUBMITTALS FOR REVIEW

- A. Section 01300 – Submittals: Procedures for submittals.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

1.7 SUBMITTALS FOR INFORMATION

- A. Section 01300 – Submittals: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate installation requirements.

1.8 SUBMITTALS FOR CLOSEOUT

- A. Section 01730 – Operation and Maintenance Data and Section 01740 – Warranties and Bonds.
- B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.9 QUALITY ASSURANCE

- A. Perform Work in accordance with manufacturer's instructions.

1.10 QUALIFICATIONS

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

PART 2 – PRODUCTS**2.1 OMITTED****2.2 MATERIALS**

- A. Framing (Steel): ASTM F1083 Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 25 ksi; coating conforming to ASTM F1043 Type A on pipe exterior and interior.
- B. Fabric Wire (Steel): ASTM A116 galvanized wire.
- C. Barbed Wire: ASTM A121 galvanized steel 14 gage thick wire, 3 strands, 4 points at 5 inch oc.
- D. Concrete: ASTM C94; Type 1 Portland Cement, 3,000 psi strength at 28 days, 4 inch slump; fine and coarse aggregate.

2.3 COMPONENTS

- A. Line Posts: 2.38 inch diameter.
- B. Corner and Terminal Posts: 3.5 inch diameter.
- C. Gate Posts: 3.5 inch diameter.
- D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- E. Gate Frame: 1.66 inch diameter for fittings and truss rod fabrication.
- F. Fabric: 2 inch diamond mesh interwoven wire, 9 gage thick, top selvage twisted tight, bottom selvage twisted tight.
- G. Tension Wire: 6 gage thick steel, single strand.
- H. Tension Band: 3/8 inch thick steel.
- I. Tension Strap: 1/2 inch thick steel.
- J. Tie Wire: Aluminum alloy steel wire.

2.4 ACCESSORIES

- A. Caps: Cast steel galvanized ; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

- C. Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.
- D. Gate Hardware: Fork latch with gravity drop, two duckbill backstop; 180 degree gate hinges per leaf and hardware for padlock.
- E. Padlocks: 2" size – No. 17 by Master Lock Co. with chain. All padlocks keyed alike.
- F. Dark green fabric, privacy slats all around the water plant.

2.5 FINISHES

- A. Components and Fabric: Galvanized to ASTM A123; 2.0 oz/sq ft coating.
- B. Omitted.
- C. Hardware: Galvanized to ASTM A153, 2.0 oz/sq ft coating.
- D. Accessories: Same finish as framing.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with manufacturer's instructions.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate, terminal, gate, and posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: 3 feet.
- E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: 3 feet.
- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
- G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- H. Install center brace rail on corner gate leaves.
- I. Do not stretch fabric until concrete foundation has cured 28 days.
- J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

- K. Position bottom of fabric 4 inches above finished grade.
- L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- N. Install bottom tension wire stretched taut between terminal posts.
- O. Install support arms sloped outward and attach barbed wire; tension and secure.
- P. Do not attach the hinged side of gate from building wall; provide gate posts.
- Q. Install gate with fabric and barbed wire overhang to match fence. Install three hinges per leaf, latch, catches, drop bolt torsion spring retainer.
- R. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.2 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Components shall not infringe on adjacent property lines.

3.3 SCHEDULES

- A. Water Plant Site.

END OF SECTION

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Section 03300 CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01-Scope

1.01.1-These specifications cover cast-in-place concrete for use in buildings, sidewalks, curb and gutters, foundations, and other related items.

1.01.2-The following subjects are considered outside of the scope of these specifications:

1. Precast concrete products.
2. Heavy duty paving concrete
3. Terrazzo
4. Insulating Concrete
5. Lightweight concrete

1.02-Americans with Disabilities Act-All concrete structures shall be designed and constructed to meet the requirements of the U.S. Department of Justice, Americans with Disabilities Act, Rev. July >97. This law requires that all new places of public accommodations and commercial facilities be designed for persons with disabilities. Required guidelines for curb ramps and other handicapped related structures shall be as specified in U.S. Department of Justice, ADA Design Guide.

1.03-Design of Concrete Structures shall be performed and stamped by a Professional Engineer registered in the State of Georgia. In no instance shall a concrete sidewalk be less than 4" thick nor a driveway less than 6" thick. The Engineer shall refer to City of Savannah Standard Construction Details for minimum design requirements of various structures.

1.04-Construction Loads Construction loads shall not exceed what the member is able to carry safely and without damage. The Contractor is responsible for providing all supplemental support necessary to protect the structure until the concrete has reached it's specified design strength.

1.05-Referenced Standards and Specifications

1.05.1-The most recent issue of each standard or specification shall be used. The following abbreviations may be used to reference the publishing organization:

ACI - American Concrete Institute, P.O. Box 9094,
Farmington Hills, MI 48333-9094.

ASTM - American Society for Testing and Materials,
100 Barr Harbor Drive, P. O. Box C700, West
Conshohocken, PA 19428-2959.

AASHTO - American Association of State Highway and
Transportation Officials 444 North Capital
Street, N.W., Suite 225, Washington DC 20001

CRSI - Concrete Reinforcing Steel Institute, 933
North Plum Grove Road, Schaumburg, IL 60173.

PART 2 - MATERIALS FOR CONCRETE

2.01-Cements

Portland cement shall conform to ASTM C 150. Portland blast furnace slag cement or portland pozzolan cement shall conform to ASTM C 595.

2.02-Admixtures

2.02.1-Admixtures to be used in concrete, when required or permitted, shall conform to the following appropriate specifications:

2.02.1.1-Air-entraining admixtures, ASTM C 260

2.02.1.2-Water-reducing, retarding, and accelerating admixtures, ASTM C494

2.02.1.3-Pozzolanic admixtures, ASTM C 618

2.02.1.4-Fiber reinforcement: fiber reinforcement shall be 1/2" or 3/4" collated, fibrillated polypropylene fibers meeting the requirements of ASTM C 1116, para. 4.1.3, Type III.

2.02.1.5-Admixtures used in the work shall be of the same composition as those used in establishing the concrete proportions.

2.03- Water

Mixing water for concrete shall meet requirements of ASTM C 94.

2.04-Aggregates

2.04.1-Aggregates for normal weight concrete shall meet the requirements for ASTM C 33 unless otherwise specified.

2.04.2-Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as the combination of sizes when two or more are used, shall meet the appropriate grading requirements of the applicable ASTM specifications.

PART 3 - PROPORTIONING

3.01- General Concrete for all parts of the work shall be of the specified quality and capable of being placed without excessive segregation. When hardened, concrete shall develop all characteristics required by these specifications and the contract documents.

3.02-Strength The specified compressive strength of the concrete (**f'c**) for each portion of sidewalks and curb and gutters shall be a minimum of 3000 psi unless a greater strength requirement is indicated on the contract drawings or herein. Driveway and road paving shall have a compressive strength of not less than 5000 psi. Strength requirements shall be based on 28-day compressive strength unless a different test age is specified. The compressive strength of the concrete shall be determined by ASTM C39.

3.03-Durability

3.03.1-Concrete shall be air entrained and shall conform to the air content limits of ACI 301-99 Table 4.2.2.4.

3.03.2-The water-cement ratio shall not exceed 0.53 by weight.

3.03.3-For all concrete in which aluminum or galvanized metal is to be embedded, it shall be demonstrated by test that the mixing water of the concrete, including that contributed by the aggregates and any admixture used, will not contain a deleterious amount of chloride ion.

3.04-Slump The concrete shall be proportioned and produced to have a slump of 4 inches or less. A tolerance of up to 1 inch above the maximum indicated shall be allowed for one batch in any five consecutive batches tested. The slump shall be determined by ASTM C 143.

3.05-Maximum size of coarse aggregate The nominal size of the aggregate shall not be more than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between

reinforcing bars. See ASTM C 33 for tolerance on oversize for various nominal maximum size designations.

3.06- Admixtures

3.06.1-The amount of calcium chloride shall not exceed 2 percent by weight of cement. The amount of calcium chloride shall be determined by the method of described in AASHTO T260.

3.06.2-For all concrete which will remain in contact with aluminum or galvanized metal, the limitation of Section 3.3.3 shall apply unless protective measures acceptable to the Engineer are provided.

3.06.3-All admixtures shall be used in accordance with the manufacturer's instructions except as otherwise specified.

3.06.4-Where fiber reinforcement is called for, it shall be added to the concrete in the manner and rate recommended by the manufacturer. Unless otherwise prohibited by the manufacturer, the minimum rate of application shall be 1 lb. of polypropylene fibers per cubic yard of concrete.

3.06.5-In the Historic District, a color additive equal to Lambert #4685 shall be added to all concrete sidewalks at the rate of 2 2 pounds per cubic yard in order to match the color of existing sidewalks.

3.07- Mix Design The Contractor shall **submit** proposed concrete mix designs for each type of concrete in the project. Proposed concrete proportions shall be subject to acceptance by the Engineer based on demonstrated ability to produce concrete meeting all requirements of the specifications. Concrete proportions shall be established on the basis of previous field experience as specified in ACI 301, Section 4.2.3 with materials to be employed in the work; or if field test results are not available, select the required test strength from Table 4.2.2.3.b of ACI 301-99. Contractor is not authorized to batch any concrete for use in this project until mix design has been approved by the Engineer.

PART 4 - FORM WORK

4.01-Form Work General Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall have sufficient rigidity to maintain

specified tolerances. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the **Contractor**.

4.02-Earth as Forms Earth cuts shall not be used as forms for vertical surfaces unless specifically allowed by the Engineer.

The Contractor is responsible for ensuring that all earth cuts meet OSHA trenching regulations.

4.03-Form Release Before placing the reinforcing steel or the concrete, the surfaces of the forms shall be covered with an acceptable coating material that will effectively prevent absorption of moisture, prevent bond with the concrete, and not stain the concrete surfaces.

4.04-Form Removal Under no circumstances shall formwork be removed prior to 24 hours after placement of concrete.

4.05-Formwork Tolerances for formed surfaces shall be in compliance with ACI 117.

4.06-ACI Formwork Standards Adherence Unless otherwise specified, formwork shall meet the requirements of ACI 301-99, Chapter 2.

PART 5 - REINFORCEMENT

5.01- Reinforcing Bars shall be deformed except spirals, which may be plain bars. Reinforcing bars shall be Grade 60 conforming to one of the following specifications: ASTM A 615, ASTM A 616(including supplementary requirement S1), ASTM A 617, ASTM A 706. If called for on plans, reinforcing bars shall be epoxy-coated in accordance with ASTM A775

5.02-Welded Wire Fabric shall be fabricated from smooth or deformed wire and shall conform to the wire size and wire spacing required or indicated on the contract drawings. Welded wire fabric shall conform to one of the following specifications:

- ASTM A 185, except welded intersections shall be spaced not farther apart than 12 inches in the direction of the principal reinforcement.

- ASTM A 497, except welded intersections shall be spaced not farther apart than 16 inches in the direction of the principal reinforcement.

5.03-Bar Supports

5.03.1-Wire bar supports shall be in accordance with Class 1, maximum protection, or Class 2, moderate protection in Chapter 3 of the CRSI Manual of Standard Practice.

5.03.2-Precast concrete brick bar supports may be used to support rebar mats or welded wire mesh in slab-on-grade construction.

5.04-Welding of reinforcing bars or welded wire fabric is specifically **prohibited**.

5.05-Fabrication of reinforcing bars shall be in accordance with the standard fabricating tolerances in ACI 117.

5.06-Placing Reinforcement

5.06.1-Reinforcement shall be placed within the tolerances specified in ACI 117 and guidelines specified in ACI 301 Section 3.3 Minimum concrete cover for reinforcement shall be as required in Table 3.3.2.3 of ACI 301.

5.06.2-Field bending of bars partially embedded in concrete shall not be permitted unless specifically accepted by the Engineer.

5.07-Sidewalks shall be reinforced by one of the following methods:

5.07.1-Welded wire mesh located 2" from the top surface of the concrete. Minimum size of mesh shall be 6"x6" - W2.9 x W2.9.

5.07.2-Concrete shall be fiber reinforced.

5.07.3-Deformed reinforcing bars providing no less than 0.25 square inches per foot (each way).

PART 6 - JOINTS AND EMBEDDED ITEMS

6.01-Construction Joints shall be located and detailed on the contract drawings. Unless otherwise indicated on the drawings, all reinforcement shall be continued across the joints.

6.02- Contraction Joints

6.02.1-Sawcut joints shall be located and detailed as indicated on the contract drawings. Cutting shall be

timed properly with the set of concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates being dislodged by the saw. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking.

6.02.2-Tooled Control Joints in sidewalks shall be provided at a spacing not greater than 10 feet on center or twice the width along it's length.

6.03-Expansion Joints

6.03.1-Expansion joints shall be located as shown on the contract drawings but shall be spaced no further apart than 80 feet along a sidewalk or curb and gutter.

6.03.2-Reinforcement or other embedded metal items bonded to the concrete (except dowels in floors bonded on only one side of joints) shall not be permitted to extend continuously through any expansion joint.

6.03.3-Premolded expansion joint filler shall conform to one of the following specification: ASTM D 994, ASTM D 1751, or ASTM D 1752.

6.04-Joint Sealant All expansion joints shall be sealed per detail on project drawings. Other joints to be sealed will be indicated on the project drawings. Joint sealant shall meet the requirements of ASTM C 920, Type S or M, Grade P, Class 25.

6.05-Curb and Gutter sections shall be constructed in sections of uniform length not to exceed 10 feet in length or be less than 5 feet in length. If slip-form or extruded construction is used, contraction joints shall be located at intervals no greater than 10 feet by sawing the hardened concrete at the proper time. The depth of the saw-cut shall be one-fourth of the thickness of the curb and gutter section. The maximum width of the cut shall be 1/4 inch and shall be sawed no later than 24 hours after the pour.

PART 7 - PRODUCTION OF CONCRETE

7.01-Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise provided in this chapter. Plant equipment and facilities shall conform to "Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.

7.02-Concrete produced by on-site volumetric batching and continuous mixing shall be batched and mixed in accordance with

and shall conform to all requirements of ASTM C 685.

PART 8 - PLACING OF CONCRETE

8.01 Preparation

8.01.1—Form work shall be completed; snow, ice and water shall be removed; reinforcement shall be secured in place; expansion joint material, anchors, and other embedded items shall be positioned; and the entire preparation shall be accepted by the Engineer or his representative prior to placing concrete.

8.01.2—The subgrade shall be well drained and of adequate and uniform load bearing capacity. The minimum in-place density of the subgrade soils shall be as required in the specifications.

8.01.3—Concrete shall not be placed on frozen ground. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50 F long enough to remove all frost from the subgrade.

8.01.4—Subgrades shall be moist at the time of concreting. If necessary, they shall be dampened with water in advance of concreting, but there shall be no standing water on the subgrade nor any muddy or soft spots when the concrete is placed.

8.02—Conveying and Placing

8.02.1—Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients and in a manner which will assure that the required quality of the concrete is maintained.

8.02.2—The loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 inches. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy.

8.02.3—Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited which has hardened sufficiently to cause the formation of seams or planes of weakness within the

section. If a section cannot be placed continuously, construction joints shall be located as indicated on the contract documents or as permitted by the Engineer. Placing shall be carried on at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened or has been contaminated by foreign materials shall not be deposited. Temporary spreaders in forms shall be removed which the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior acceptance has been obtained by the Engineer.

8.02.4—Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to any procedure which will cause segregation.

8.02.5—All concrete shall be consolidated by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Use of vibrators to transport concrete within forms shall not be allowed. A spare vibrator shall be kept on the job site during all concrete placing operations.

8.02.6—Unless adequate protection is provided and acceptance is obtained from the Engineer, concrete shall not be placed during rain, sleet, or snow.

8.02.7— Except as below, the temperature of the plastic concrete, as placed, shall be no lower than 55 F and no higher than 90 F. The air temperature shall be **at least 35 degrees F** and rising when concrete is mixed and placed. When the average of the highest and lowest temperature during the period from midnight to midnight is expected to drop below 40 degrees F for more than three successive days, deliver concrete to meet the requirements of Table 4.2.2.7 of ACI 301-99.

8.02.8 - Protection. Immediately after placement protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury. Protection measures shall conform to Section 5.3.6.5 and 4.2.2.7 of ACI 301-99.

PART 9 - REPAIR AND REPLACEMENT

9.01-Repair of Surface Defects: All honeycombed and other defective concrete shall be removed down to sound concrete and patched. When chipping away loose or defective material, no featheredging will be permitted.

9.02-Tie holes shall be plugged with patching mortar unless stainless steel, noncorrosive, or acceptably coated ties are used.

9.03-Saw Cuts Where a portion of an existing concrete driveway or sidewalk is removed, the existing section shall be cut to a minimum depth of 4-inches with a suitable saw prior to breaking out pavement.

PART 10 - SURFACE FINISHES

10.01-Formed Surfaces of concrete shall be given the finishes specified below unless the contract documents specify otherwise:

Rough form finish - For all concrete surfaces not exposed to public view

Smooth form finish - For all concrete surfaces exposed to public view.

Public View - Defined as any surface of the finished concrete that may be seen by a person without excavating soil.

10.01.1-Rough form finish - No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Fins exceeding 1/4 in. in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with texture imparted by the forms.

10.01.2-Smooth form finish - The form facing material shall produce a smooth, hard, uniform texture on the concrete. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Materials with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. All fins shall be completely removed. No later

than the day following form removal, the concrete surfaces shall be wetted and rubbed with carborundum brick or other abrasive until uniform color and texture are produced.

10.01.3- Tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

10.02- Slab Finishes

Unless otherwise specified on the contract documents, the following finishes shall be used as applicable:

Broom or belt finish - For sidewalks and garage floors and ramps.

Floated Finish - For surfaces intended to receive roofing, waterproofing membranes, or sand bed terrazzo.

Troweled finish - For floor intended as walking surfaces or for reception of floor coverings.

Non-solid finish - For exterior platforms, steps, and landings; and for exterior and interior pedestrian ramps.

10.02.1- Floated Finish: After the concrete has been placed, consolidated, struck off, and leveled, the concrete shall not be worked further until ready for floating. Floating with a hand float or with a bladed power trowel equipped with float shoes, or with a powered disc float shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. All high spots shall be cut down and all low spots filled during this procedure. The slab shall then be refloated immediately to a uniform sandy texture.

10.02.2- Troweled finish: The surface shall first be float-finished as specified in Section 10.2.1. It shall next be power troweled, and finally hand troweled. The first troweling after power floating shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Additional troweling shall be done by hand after the surface has

hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be essentially free of trowel marks, uniform in texture and appearance and shall be plane to required tolerances.

10.02.3- Broom or belt finish: Immediately after the concrete has received a float finish as specified in Section 10.2.1, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

10.02.4- Non-slip finish: Crushed ceramically bonded aluminum oxide or other specified selected abrasive particles shall be blended with Portland cement in the proportions recommended by the manufacturer of the aggregate. The surface shall be given a float finish in accordance with Section 10.2.1. Approximately two-thirds of the blended material for required coverage shall be applied to the surface by method that insures even coverage without segregation. Floating shall begin immediately after application of the first "dry shake". After this material has been embedded by floating, the remainder the blended material shall be applied to the surface at right angles to the previous application. A second floating shall follow immediately. The rate of application of such material shall be not less than 25 lb. per 100 square feet.

10.02.5- Slab finishing tolerances: Unless otherwise called out in the contract documents, finishes shall be true planes within 1/4 inch in 10 feet as determined by a 10-ft. straightedge placed anywhere on the slab in any direction. The maximum variation in elevation for a level slab shall not exceed 3/4 inches over the entire slab.

PART 11 - CURING AND PROTECTION

11.01- General: Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete.

11.02- Preservation of Moisture

11.02.1- For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing:

11.02.1.1- Ponding or continuous sprinkling.

11.02.1.2- Application of absorptive mats of fabric kept continuously wet.

11.02.1.3- Application of waterproof sheet materials conforming to ASTM C 171.

11.02.1.4- Application of a curing compound conforming to ASTM C309 in accordance with manufacturer's recommendation. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond.

11.02.2- Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal the concrete shall be cured until the end of the time prescribed in Section 11.2.3 by one of the above methods.

11.02.3- Curing in accordance with the above requirements shall be continued for at least 7 days in the case of all concrete except high-early strength concrete for which the period shall be at least 3 days.

11.03- Temperature Control. When the mean daily outdoor temperature is less than 40 F, the temperature of the concrete shall be maintained between 50 and 70 F for the required curing period of Section 11.2.3. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

PART 12 - TESTING

12.01- Owner Paid Testing. Field sampling and testing shall be performed by an independent testing lab hired and paid for by the Owner. Samples of concrete shall be taken at random locations and at such times to represent the quality of the materials and work throughout the project. The laboratory shall provide the necessary labor, materials, equipment, and

facilities for sampling the concrete and for casting, handling and storing the concrete samples at the site of work. Sampling of plastic concrete will be in accordance with ASTM C172. Samples for pumped concrete shall be taken at the hose discharge point. Samples for other concrete shall be taken at the hopper of concreting equipment or transit mix truck.

12.02-Contractor Paid Testing The Contractor shall pay for the following services when required:

12.02.1- All testing, test results, or certifications required to verify that a proposed material item or mix design meets the requirements of the specifications.

12.02.2- Additional testing and inspection required because of changes in materials or proportions requested by the Contractor.

12.02.3- Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements. For example, if compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C 42 and any other load tests acceptable to the Engineer. Costs of such tests will be borne by the Contractor.

12.03-Test Scheduling To facilitate testing and inspection, the Contractor shall advise the Owner and the designated testing agency sufficiently in advance of operations to allow for the assignment of personnel and for the completion of quality tests and inspection of forms.

12.04-Strength Tests

12.04.1-General: The strength of the concrete will be verified by the testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site.

12.04.2-Frequency: As a minimum, one set of four standard cylinders shall be cast of each class of concrete based on the most stringent of the following requirements as applicable:

- For each 50 cubic yards or less
- For each 100 feet of sidewalk
- For each 200 feet of curb and gutter

- For each 4000 square feet of surface area
- For each day a pour is made

12.04.3-Lab testing: Testing of specimens for compressive strength shall be in accordance with ASTM C39. Tests shall be made at 7 and 28 days from time of casting. Two test cylinders from each group of four shall be tested at the end of 7 days and two shall be tested at the end of 28 days. Each strength test result shall be the average of the strengths of two test cylinders (cast from material taken from a single load of concrete) at 28 days.

12.04.4-Acceptance of Concrete Strength: The strength level of the concrete will be considered satisfactory so long as the average of all sets of three consecutive strength results equal or exceed the specified strength $f'c$ and not more than 10% of the strength test results shall have values less than this value. No individual strength test shall be less than the specified strength $f'c$ by more than 500 psi.

12.05-Slump Tests: The slump shall be as specified when measured in accordance with ASTM C 143. Samples for slump determination shall be taken from the concrete during placing. Tests shall be made at the beginning of concrete placing operations and at subsequent intervals to insure that the specification requirements are met. When concrete is pumped, slump tests shall be taken from concrete at the discharge end of the pump hose. Slump tests shall also be performed whenever standard cylinders are cast.

12.06-Temperature and Air Content Tests: Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Whenever standard cylinders are cast, temperature tests shall be performed.

Air content tests shall be in accordance with ASTM C 231 and shall be measured whenever standard cylinders are cast.

PART 13 - FLOWABLE FILL

The mixture of dry material per cubic yard shall be 50 pounds cement, 600 pounds fly-ash, and 2,500 pounds sand. Depending on the slump requested for the specific job, water added shall be 65 gallons (541 pounds) for a 6-inch slump, to 55 gallons (458 pounds) for a 3-inch slump. One cubic yard of 6-inch slump will contain more than 27 cubic feet due to the additional water. Unconfined compressive strength will be 80 psi at 7 days and 150 psi at 28 days.

PART 14 - GROUT-FILLED FABRIC MAT

Grout-filled fabric mat (revetment) shall be one of the following:

- 1 HYDROTEX™ Filter Point Forms (FP400) as manufactured by Hydrotex Synthetics, Inc.; 74 Perimeter Center East, Suite 7420; Atlanta, Georgia 30346-1803, Tel: 1-800-225-0023; or
- 2 Fabriform Filter Point (8" FP) as manufactured by Construction Techniques, Inc., P.O. Box 360007, Cleveland, OH 44136, Tel: 1-800-563-5047; or
- 3 **Owner**-approved equivalent.

The **Contractor** shall adhere to all recommendations published in the respective manufacturer's Construction & Quality Control Manual or similar publication.

END OF SECTION 03300

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SECTION 11100

SUBMERSIBLE WASTEWATER PUMPING STATIONS

PUMP TO CONTROL PANEL

PART 1 – PRODUCTS

1.01 PUMP DESIGN

- A. General: Each pump shall be suitable for service in raw, unscreened sewage with 3 inch solids and shall conform to the requirements shown on the Drawings for flow rate, total dynamic head, horse power, voltage and phase. Pumps shall be as manufactured by Flygt or approved equal.
- B. Qualifications of Manufactures: The pump manufacturer shall have a minimum of 10,000 heavy-duty submersible wastewater pumps installed and operating for no less than 5 years in the United States.
- C. Design Requirements: Furnish and install submersible non-clog wastewater pump(s). Each pump shall be equipped with a close coupled, submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz, and 4 wire service with submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. The pump shall be supplied with a mating cast iron discharge connection and be capable of delivering the design flow and total discharge head. Each pump shall be fitted with stainless steel (304 S.S.) lifting chain or stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight. The design operating point shall be as near as possible to the best efficiency point of the selected motor.
- D. Pump Design: The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two parallel guide bars extending from the top of the station to the wet well mounted discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump/motor unit shall bear on the sump floor directly or on a sump floor mounted stand.

Power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment loops or tails to connection to the underside of the access frame.

- E. Pump Construction: Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming

into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit. Rectangular cross sectioned rubber, paper or synthetic gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

- F. Cooling System: Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pump-age, through the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasket and bolted inspection ports of not less than 4"Ø located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104° F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40° C are not acceptable.
- G. Cable Entry Seal: The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

1.02 PUMP MOTOR

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180° C (356° F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40° C (104° F) with an 80° C temperature rise and capable of at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches shall be embedded in the stator end coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40° C (104° F) ambient and with a temperature rise not to exceed 80° C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of at least 65 feet.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

- A. Pilot Cable: The pilot cable shall be designed specifically for use with submersible pumps and shall be type SUBCAB (Submersible Cable). The cable shall be shielded, multi-conductor type with a chloroprene outer jacket and the tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 600 Volts and 90° C (194° F) with a 40° C (104° F) ambient temperature and shall be approved by Factory Mutual (FM). The cable length shall be adequate to reach the junction box without the need for

splices.

- B. Bearings: The pump shaft shall rotate on at least three grease lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.

The minimum L10 bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.

The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

- C. Mechanical Seal: Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. For special applications, other seal face materials shall be available.

Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.

The following seal types shall not be considered acceptable or equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to affect sealing shall be used. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate continuously while non-submerged without damage while pumping under load.

Seal lubricant shall be FDA Approved, nontoxic.

- D. Pump Shaft: Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel ASTM A 572 Grade 50 and shall be completely isolated from the pumped liquid.
- E. Impeller: The impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, multiple vane, double shrouded non-clogging design, having long through-lets without acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impeller(s) shall be keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum 3-inch diameter solid. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.
- F. Wear Rings: A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a Nitrile rubber coated steel or brass ring insert that is drive fitted to the volute inlet. This pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.
- G. Volute: Pump volute(s) shall be single-piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.
- H. Protection: All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor, and activate an alarm.
- I. Pump Motor Electrical Material:
 - 1. All materials shall be new and shall conform to the applicable standard or standards where such have been established for the particular material in question. Publication and Standards of the organizations listed below are applicable to materials specified herein:
 - a. American Society for Testing and Materials (ASTM)
 - b. Underwriters' Lab (UL)
 - c. National Electrical Manufacturer Association (NEMA)
 - d. Insulated Power Cable Engineers Association (IPCEA)
 - e. Institute of Electrical and Electronic Engineers (IEEE)
 - f. Edison Electrical Institute (EEI)
 - g. National Fire Protection Association (NFPA)
 - h. American National Standards Institute (ANSI)
 - i. American Iron and Steel Institute (AISI)
 - 2. Materials of the same type shall be the product of one manufacturer.

3. No IEC Rated Type "P" Device. Underwriters' Laboratory listed material shall bear U.L. Label. Also, no adjustable circuit breakers are to be used.

1.03 SUBMITTALS

The submittals for submersible pump, motor, guide rail system shall include, but not be limited to the following information relative to submersible pump, motor and guide rail system features:

- A. Pump:
 1. Head capacity efficiency curves
 2. Duty point
 3. Input power (KW), voltage, phase, frequency, power factor
 4. Efficiency and brake horsepower
 5. Construction details: body, vane, impeller, minimum clearance between impeller and volute; vanes, pump dimensions, pump base, discharge nozzle, adapter, seals, bearings, bearing life, bolts, hooks, etc.
 6. Weight
 7. Centerline distance between two pumps
 8. Clearance from walls, floor
 9. External coating details of materials, applications, etc.
 10. Operating and maintenance information
- B. Guide bar rail system: dimensions, material of guide bars, guide bar supports, hooks, clearance from wall, centerline distances, etc.
- C. Motor:
 1. Outline dimensions, weight, construction details, terminal board, seals, shaft dimensions, torque data and structural design data for motor shaft, so cable, bearings, bearing life, etc.
 2. Where a winding over temperature device is required, provide a response curve or the temperature device.
 3. Operating and maintenance information and overhaul instructions for each motor 5 H.P. and over.

1.04 WARRANTY

- A. Warrant at 100% all parts and labor for one (1) year that covers normal wear and tear for typical sewage pump applications.
- B. The manufacturer shall provide a 100% full coverage warranty for one year (12 months) from the date of acceptance of the pump station by the City for operation and maintenance. For years 2 - 5 of the service contract, the manufacturer shall provide warranty work on a pro-rated basis. A manufacturer's service representative and the Conveyance and Distribution Director or designee shall work together to make joint

resolutions of all warranty work, as well as, all other maintenance needs. The manufacturer shall also provide a service representative authorized by the pump manufacturer. Any work carried out by the authorized representative shall not violate manufacturer's warranty.

- C. A four-hour response to service call by the City shall be provided by the service representative. The service representative shall restore pump to service within five (5) working days.
- D. Service Manual - The pump manufacturer shall furnish the Owner with a minimum of six (6) service manuals for the pumps installed.
- E. The pump manufacturer shall provide the identification of manufacturer's contact person and beeper number and an alternate name and number for 24-hour availability.

PART 2 – TESTING

2.01 CONSTRUCTION OBSERVATION

- A. The submersible pumps shall be installed and tested by the Contractor under the direction of the Engineer or his Inspector. The Engineer or his Inspector will have the right to require that any portion of the work be done in his presence, and if the work is completed after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer or his Inspector that such work is scheduled and the Engineer or his Inspector fails to appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer, his Inspector, or project representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer or his Inspector for the rejection of such materials. The Engineer or his Inspector shall have the right to mark rejected materials so as to distinguish them as such.
- B. The Contractor shall give the Project Engineer, his Inspector, or Project Representative a minimum of 48 hours notice for all required observations or tests.
- C. Equipment furnished under other sections of these specifications, to be connected under this section of the specifications, shall include, but not be limited to, pump station equipment.
- D. The Contractor's attention is directed to other sections of these specifications where equipment requiring electrical service is specified. It is also necessary to be aware of the scope of work under this section of these specifications requiring electrical service and connections to equipment specified elsewhere.

2.02 ACCEPTANCE OF PORTIONS OF THE WORK

The Owner reserves the right to accept and use any portion of the work whenever it is considered to his interest to do so. The Engineer or his Inspector shall have power to direct in what area the Contractor shall work and the order thereof. The Contractor shall complete the Lift Station Data sheets (5) at the end of this section fully prior to the Owner's acceptance.

2.03 PUMP TEST

- A. Testing performed upon each pump shall include the following inspections:
 - 1. Impeller, motor rating and electrical connections shall be checked for compliance with this specification.
 - 2. Prior to submergence, each pump shall be run dry to establish correct rotation.
 - 3. Each pump shall be run submerged in water.
 - 4. Motor and cable insulation shall be tested for moisture content or insulation defects.
- B. Upon request, a written quality assurance record confirming the above testing/inspections shall be supplied with each pump at the time of shipment.
- C. Each pump shall be tested in the field to provide a field certified pump curve with the initial draw down documentation submitted in accordance to lift station data sheets shown in Subpart 2.04 of this specification.
- D. The pump(s) shall be rejected if the above requirements are not satisfied.
- E. Start-up Service: The equipment manufacturer shall furnish the services of a qualified factory trained field service engineer for an 8-hour working day(s) at the site to inspect the installation and instruct the owner's personnel on the operation and maintenance of the pumping units. After the pumps have been completely installed and wired, the contractor shall have the manufacturer do the following:
 - 1. Megger stator and power cables.
 - 2. Check seal lubrication.
 - 3. Check for proper rotation.
 - 4. Check power supply voltage.
 - 5. Measure motor operating load and no load current.
 - 6. Check level control operation and sequence.
 - 7. Submit a completed Subpart 2.04 for approval by the Engineer.
 - 8. Pumps shall clear the hatch of the wet well top without impedance.

During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the owner's personnel.

- F. Factory Service: Factory-Approved service facilities with qualified factory trained mechanics shall be available for prompt emergency and routine service. The pump manufacturer shall warrant the pumps in writing against defects in workmanship and material for a period of five (5) years or 10,000 hours of normal use, operation and service. The warranty shall be in printed form and apply to all similar units. Warranty shall cover both parts and labor on a pro-rated basis after the first year. The first year warranty shall cover 100 percent labor and materials cost.

- G. Operation and Maintenance Manuals: The manufacturer shall furnish to the owner six (6) sets of its Operation and Maintenance Instruction Manuals and parts List.

2.04 LIFT STATION DATA SHEETS

LIFT STATION NAME: _____ Number: _____

Address: _____ Cross Street: _____

Station Power:

Voltage: _____ Phase: _____ Amperage: _____ Gen Set: _____ Plug: _____

Sub Station: _____ Feeder Number: _____

Transformer Number: _____ Account Number: _____

Conveyance Information:

Pumps to: _____ Serves: _____

Equipment:

RTU:

Model Number: _____ Serial Number: _____ DS

Controls:

Manufacturer: _____ Model Number: _____

Serial No.: _____ Vendor: _____

Contract Services: _____ Phone #: () - _____

Contact: _____ Emergency #: () - _____

Pumps:

Manufacturer: _____ Model Number: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

Serial #: _____ Number: _____ Impeller Code: _____ HP: _____

GPM: _____ TDH: _____

Vendor: _____ Phone Number: () - _____

Contract Services: _____ Phone Number: () - _____

Contact: _____ Emergency Number: () - _____

Gen Set:

Manufacturer: _____ Model Number: _____
 Serial Number: _____ KVA: _____ M.C/B: _____
 Vendor: _____ Phone Number: () - _____
 Contract Services: _____ Phone Number: () - _____
 Contact: _____ Emergency Number: () - _____

Transfer Switch:

Manufacturer: _____ Model Number: _____
 Serial Number: _____ KVA: _____
 Vendor: _____ Phone Number: () - _____
 Contract Services: _____ Phone Number: () - _____
 Contact: _____ Emergency Number: () - _____

Odor Systems:

Manufacturer: _____ Model Number: _____
 Vendor: _____ Phone Number: () - _____
 Contract Services: _____ Phone Number: () - _____
 Contact: _____ Emergency Number: () - _____

Equipment: _____

By-Pass: Type: _____
 Manufacturer: _____ Model Number: _____
 Vendor: _____ Serial Number: _____
 Description: _____

Contract Services: _____ Phone Number: () - _____
 Contact: _____ Emergency Number: () - _____

Building Type: _____ Bldg Size (L x W): _____
 Finished Floor Elevation (NAVD '88): _____ # of Floors: _____ # of Rooms: _____
 Fence Type & Height: _____ Lot Size (L x W): _____

Gates: Number Gates: _____ #1: x _____ #2: x _____ #3: x _____
 Sump Pump: _____ HP: _____ GPM: _____ TDH: _____ Voltage: _____ Phase: _____

Fan: _____ HP: _____ RPM: _____ FPM: _____ Voltage: _____ Phase: _____
Heater: _____ BTU: _____ Voltage: _____ Phase: _____ Wattage: _____
A/C: _____ BTU: _____ Voltage: _____ Phase: _____
Hoist: _____ Tons: _____ ft/sec: _____ Clearance: _____ ft Length: _____ ft
Electric? Y/N Volts: _____ Phase: _____

Miscellaneous Equipment:

Description: _____ Voltage: _____ Phase: _____
Description: _____ Voltage: _____ Phase: _____
Description: _____ Voltage: _____ Phase: _____
Description: _____ Voltage: _____ Phase: _____

Comments: _____

Data: Last Update: _____
Date: ____/____/____
Station Construction: \$ _____
Start Up Date: ____/____/____
Warranty Description: _____
Warrantor: _____
Expires: ____/____/____

Wet Well Data:

Square _____ Rectangular _____ Circular _____ (Check Applicable Shape)
Length: _____ feet _____ inches Diameter: _____ feet _____ inches
Width: _____ feet _____ inches Depth: _____ feet _____ inches

Elevation at center of Pump Motor: _____ feet Elevation at top of Wetwell: _____ feet
Elevation at bottom of Inflow Pipe: _____ feet Inflow Pipe Diameter: _____ inches
Elevation at top of lowest Manhole: _____ feet Elev. of lowest House Lateral: _____ feet

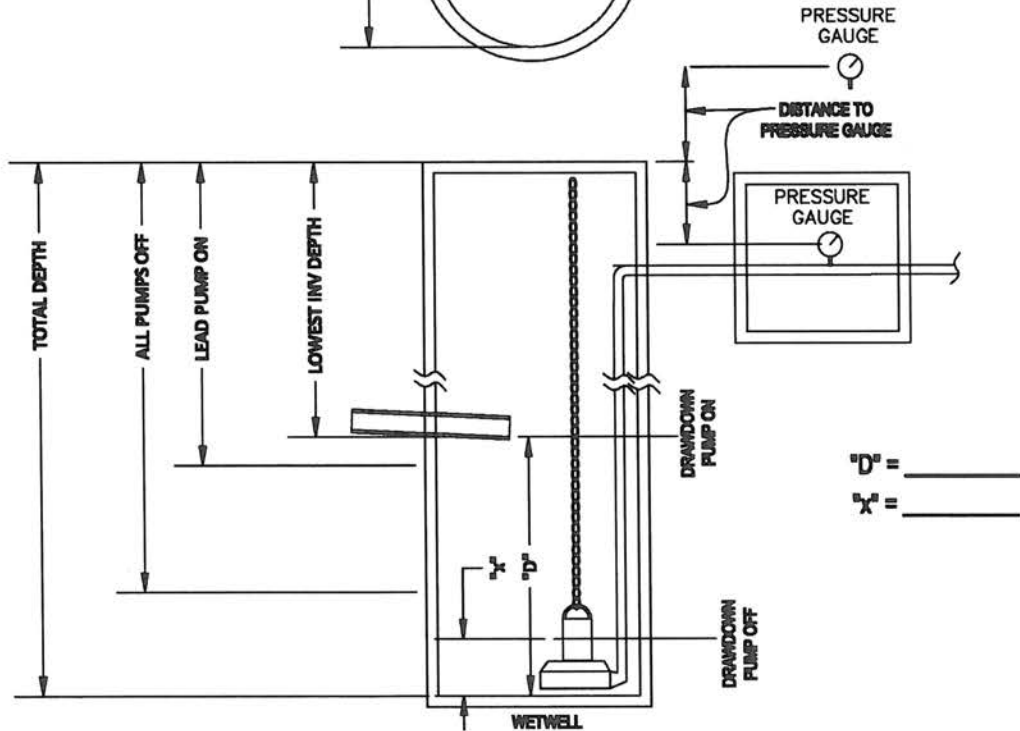
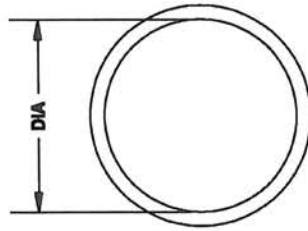
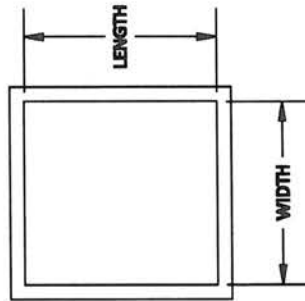
Pump Guide Bars:

Total Length: _____ feet _____ inches Dia.: _____ inches Middle Bracket: Y / N
Pump Base (Ø): _____ inches
Station Force Main Size (Ø): _____ inches By-pass Cam-lock Size: _____ inches

Remarks: _____

LIFT STATION DRAWDOWN SKETCH

LIFT STATION NO. _____



PUMP MODEL: _____ VOLUME (GAL/FT): _____
 PUMP HP: _____ AVG PUMP RATE (GPM): _____
 IMPELLER (mm or Code): _____ INFLUENT FLOW AVG (GPM): _____
 VOLUTE (In): _____

PART 3 – FINAL INSPECTION

3.01 FINAL INSPECTION / ACCEPTANCE

- A. Field Pumping Test:
 - 1. The Water and Sewer Conveyance and Distribution Director or his representative shall be present at time of this test. Perform a minimum of two pump tests with each pump for a minimum of three flow discharges with each pump pumping with the discharge valve set as follows:
 - a. Closed
 - b. Full Open
 - c. Throttled
 - 2. During final inspection, the contractor, in the presence of the Owner's representative, shall remove each pump using the hoist beam, set the pump on the top slab, reinstall the pump and start up the pump with no interference or excess force.

- B. Dry Pumping Test: The pump will be tested in one of two ways; Facility Test or Site Test:
 - 1. Facility Test: A facility designed for testing of pumps and motor, with control over liquid level, head conditions, current, voltage and temperature, also monitoring and recording of data. Snore conditions may occur for an estimated period of 4 hours or 45 seconds.
 - 2. Site Test shall be performed as follows:
 - a. Current and pump/motor temperature shall be recorded.
 - b. Pump to be set as designed in station on base.
 - c. Force main shall be plugged.
 - d. By-pass valve open, with a cam-lock pipe connected shall be in place so water can flow back into wetwell.
 - e. Wet well shall be filled to centerline of volute (more water may be added to maintain centerline).
 - f. Pump shall be placed on line.
 - g. By-pass valve shall be adjusted to meet designed duty point.Snore may occur due to turbulence and liquid level pump down. The Water and Sewer Conveyance and Distribution Director reserves the right to have this test performed for each pump by the manufacturer and/or supplier of the pumps.

3.02 PERSONNEL REQUIRED FOR INSPECTION

- A. General Contractor
- B. City Engineering Departments
- C. Conveyance and Distribution applicable personnel

- D. Civil and Electrical Engineering Consultants
- E. Pump and Control Manufacturer
- F. Emerson / Bristol Babcock for SCADA

PART 4 – ELECTRICAL / ELECTRONIC SUB-SYSTEM(S)

4.01 GENERAL

The electrical/electronic system of the pumping station shall consist of the below listed integrated capabilities which shall be required to successfully accomplish the objective of ensuring automatic operation of the pumping system. The minimum services/installations shall be:

- A. Installation/activation/integration of the primary utility power source with all of the station electrical sub-systems in compliance with the supplying utility's installation guidelines and with NFPA 70 (National Electrical Code) standards.
- B. A means to easily switch the station electrical load from the commercial electric power grid to an Emergency Power System (Generator) in the event of failure of the commercial power. This sub-system shall be in compliance with NFPA 70, NFPA 110, US EPA Standard 40 CFR 89, and all other standards cited in Standard Specification 16620 found on the City of Savannah website as applicable.
- C. A stationary Emergency Power System (Diesel Generator Set and Automatic Transfer Switch) which shall be capable of providing electrical power to the station as outlined in City of Savannah Standard Specification 16620.
- D. An integrated interconnection wiring system which shall interface with the SCADA system to:
 1. Annunciate alarms and status of HOA switch position, Pump running, Pump and/or Pump Control has failed, Main Circuit Breaker status, Power Source (Utility or EPS) is providing power to the station, Wet Well High Level Alarm condition, a 4-20ma signal proportional to the wet well level, a 4-20ma signal proportional to pump running amperes, and a 4-20ma signal proportional to station flow meter reading (as applicable). These signals/alarms shall apply for each and every pump at the station as applicable in the individual station contract documents.
 2. Allow the SCADA system to assume control of the station through its on-board "Watchdog and CMD" system as back-up to the primary process control system at the pumping station.
- E. An integrated interconnection wiring system which shall interface with the Cellular Alarm Panel to annunciate:
 1. Station wet well is in a "High Level" condition.

2. The station primary 3-phase power is not correct.
 3. A pump/pump control is in failure mode.
 4. The back-up Emergency Power System is supplying primary power to the station.
 5. Provide Mission Communications M800 RTU
- F. The cellular alarm panel shall be mounted in the control room or on the back board, as applicable.
- G. A Emerson (Bristol) Process Management "Control Wave" SCADA system to include antenna. The SCADA panel shall be located in the station control room or be mounted on the station main backboard.
- H. A power distribution system which allows for the TOTAL isolation and removal of power from individual pump motor control enclosures at stations which have separate pump motor control enclosures without having to remove power from any other device within the overall system. This will generally apply to stations which have an on-site building structure which contains the control panels and power distribution sub-system, (an "I-Line" style distribution panel configuration is recommended).
- I. At pump stations with separate and individual pump controls in a building structure, a master level control panel shall serve as the primary control interface for automatic operational control of the station primary functions. Refer to Section 5 of this Specification for details.
- J. The station shall have indoor and outdoor lighting located such that any and all repair/maintenance activities may readily take place during the night without the deployment of temporary lighting systems. Light fixtures shall utilize LED technology.
- K. The station shall have 120VAC convenience receptacles located indoors and outdoors such that power tools and etc. may be operated without the use of extension cords greater than 50 feet in length at any location within the station. These receptacles shall be configured as duplex NEMA 5-20R devices.
- L. Stationary Generator Sets shall have a minimum two circuits for generator auxiliary loads: generator coolant heater, generator battery charger, service light, etc. Provide 240V single phase or 120V single phase as required.
- M. The cellular alarm panel shall have its own dedicated receptacle configured as a duplex NEMA 5-20R device located within one foot to the alarm panel inside a building structure or inside its respective enclosure as applicable. This receptacle shall be powered from its own dedicated 20 AMP circuit breaker. This receptacle shall be a Hubbell HBL53605A surge protection receptacle.

4.02 BASIC ARRANGEMENT OF THE LIFT STATION ELECTRICAL SUB-SYSTEMS

- A. Lift Stations shall not have any electrical device/panel other than convenience receptacles or lighting fixtures mounted to the exterior surfaces of any building structure on the property. All exterior electrical devices/panels shall be mounted to free-standing backboard structures. The backboard structures shall be constructed as follows:
1. Pressure treated wood used for construction of the equipment backboards shall conform to the following:
 - a. Pressure treated wood shall be preserved using chromated copper arsenate (CCA), use category UC4B, and labeled by the manufacturer with AWPA listing for ground contact.
 - b. All end-grain of timber vertical supports and horizontal boards, all field cuts, and all bored/drilled holes shall be field treated with two coats of copper naphthenate (Tenino).
 - c. The vertical timber supports and the horizontal boards shall be painted with two coats of waterborne solid color deck stain (Sherwin Williams Super Deck Series), stain color shall be Sherwin Williams SW3009 (Pineneedle). One coat shall be applied prior to installation/assembly, the final coat shall be applied before mounting of electrical equipment. The finish shall be retouched before final acceptance.
 - d. Horizontal boards shall be attached to the vertical timbers using two 1/2" stainless steel bolts on each end. Provide oversize "fender" type stainless steel washers under the bolt head and the nut.
 - e. Equipment shall be attached to the horizontal boards using four 3/8" stainless steel bolts one at each corner. Provide oversize "fender" type stainless steel washers under the bolt head and the nut.
 2. The main equipment backboard shall be located a minimum of 10 feet away from the wet well and shall not be placed in a location which may interfere with the entry/exit and safe operation of a mobile crane or boom truck during the installation or retrieval of pumps/other equipment located inside the wet well.
 3. The backboard for wet well junction boxes and/or disconnect switch devices shall be located adjacent to the wet well.
 4. Any additional backboards shall be located such that they meet the requirements of "1" and "2" above and be located near/along the security fence line as applicable.
 5. Specific location(s) of backboard assemblies shall be as shown on the contract drawings.
 6. Backboard Construction Details – Main Backboard:
 - a. The backboard support posts shall be anchored in round concrete foundation forms (Sonotube). Foundation dimension shall be 18" diameter x 48" deep. Posts shall be set in the center of the forms to a depth of 36".

- b. The support posts shall be 6" x 6" pressure treated timber as specified above. The maximum span between posts shall not exceed 72", center to center. For backboards exceeding 72", a third post shall be provided in the middle. The assembly shall be capable of supporting the weight of all mounted equipment without sagging or leaning. Angle support bracing is not permitted; furnish additional support posts and concrete foundations as required. All equipment shall be mounted on the front of the backboard; rear mounted equipment will not be accepted.
 - c. Concrete pads or other such structure(s) under the backboard assembly are prohibited except for foundation bases for free standing control panels. This area shall be clear to facilitate the installation of electrical conduit to/from the devices and equipment.
 - d. The support post elevation above finished grade shall provide for attachment of the required number of cross pieces such that the bottom of all devices mounted to the final assembly is a minimum of 24 inches above finished grade and that the top of the tallest enclosure/device is not less than four (4) inches below the top edge of the cross pieces.
 - e. The backboard cross pieces shall consist of 2" x 8" pressure treated lumber of sufficient length and numbers to accommodate the mounting of all of the devices which are to be mounted to it leaving sufficient space between the devices (6" between enclosures minimum) for air flow and the installation of interconnecting electrical conduit. All equipment and conduit shall be mounted to the front of the backboard assembly.
7. Backboard Construction Details – Other Backboards:
- a. All other backboard assemblies required shall conform to the provisions of "6." above, except that the support posts may consist of 4" x 6" pressure treated lumber posts due to the potentially reduced amount of weight which they will be supporting.
 - b. The final location of these backboard assembly(s) shall be as designated on the individual station contract drawings.
 - c. Backboards shall be provided for utility meters and service disconnects.
8. Backboard Assembly Details:
- a. Where field conditions require that the assemblies/other devices mounted to the backboard(s) are mounted higher than specified above finished grade, a free-standing maintenance platform shall be constructed in front of the backboard assembly which may be easily moved by one person so that conduits and/or other items underneath it may be readily accessed. The platform shall be fabricated from 2" x 6" pressure treated lumber and decked with fiberglass grating. The working platform shall extend the length of the backboard and be 48" wide.
 - b. The backboard component pieces (boards) shall be assembled utilizing thru-bolt techniques with hex-head stainless steel bolts, nuts, fender washers, and lock-washers. Fender washers shall be used under the bolt

head and nut. The use of lag bolts, wood screws, decking screws and etc. will not be accepted.

- c. The assembly bolt heads on the "front" side of the assembly shall be countersunk such that a flat surface is presented to the equipment be mounted on it.
 - d. All hardware and countersunk depressions shall be protected and painted prior to the mounting of any equipment on the backboard.
 - e. All equipment/devices mounted to/on the backboard assembly shall be securely fastened to the backboard assembly utilizing thru-bolt mounting techniques with hex-head stainless steel bolts, nuts, washers and lock washers. The use of lag bolts, wood screws, decking screws, and etc. shall not be acceptable.
9. Miscellaneous Backboard Details:
- a. When fully assembled with all the equipment mounted; the backboard(s) shall stand plumb with no sag or droop of the cross pieces.
 - b. The backboard(s) shall stand firmly and not tilt, lean, or wobble when pushed from either the side or from the ends.
 - c. Following complete assembly of all devices to the backboard, the paint shall be touched up to eliminate scars, gashes, or other marring defects such that it presents a finished and professional appearance.

B. Pump Stations with pumps of 60 HP or greater will usually have a Control Room building which houses most of the electrical control system except for that which is required to be located outdoors. For those portions of the electrical system located outdoors, the above described criteria for backboard construction shall apply. For the portion(s) of the system located indoors; the following requirements shall be applicable:

1. The control room shall be arranged such that all equipment systems are located around the inside perimeter of the control room and interconnected with appropriate conduit raceways required for interconnecting wiring.
2. Receptacles, light switches, and other such devices shall be surface mounted. Do not install flush mounted.
3. Indoor lighting shall be provided for all interior spaces. Temporary lighting systems, under normal conditions, shall not be required.
4. Lighting fixtures shall be INDUSTRIAL grade devices compliant with OSHA and National Electrical Code standards. These fixtures shall be installed unobstructed.
5. Equipment enclosures inside the control room building shall be rated NEMA 1 or NEMA 12.
6. Equipment/enclosures located outside of the control room building shall be rated NEMA 3R or NEMA 4X.

4.03 DETAILED TECHNICAL DESCRIPTIONS OF CONTROL SYSTEM SUB-ASSEMBLIES

- A. Refer to Section 16000 for Wires and Conduit descriptions.
- B. Refer to Section 16482 for Pump Motor Starter/Drive descriptions.
- C. Refer to Section 16400 for Flow Measurement Equipment.
- D. Refer to Section 16620 for Emergency Power Back-Up Systems.

4.04 PRIMARY UTILITY POWER GRID INTERFACE TO PUMPING STATION

- A. The pumping station shall be connected to the utility power grid IAW NFPA 70 (National Electrical Code) standards and the installation standards of the supplying electric utility company. Field coordinate with the electrical utility.
- B. The entry point for electrical utility power to the station shall be located as close to the perimeter fence of the station as is allowable by the utility company. The type of interface connection (pole, pedestal, or stand-alone transformer) shall be coordinated with the utility company.
- C. The utility connection point shall not be located such that overhead wiring extends beyond five (5) feet within the perimeter fence of the station. In no case shall overhead wires (power or telecommunications) be located closer than 30 feet of the boom truck/ crane operation area required to service the station wet well.
- D. All station utility metering, required CT auxiliary enclosures and station service disconnects shall be mounted on a separate backboard located as close to the utility power pole as is permitted by the utility company regulation guidelines and shall comply with NFPA 70. Do not mount meter cans or other devices on the utility power pole unless required by the electrical utility.
- E. The utility interface back board shall have the following items mounted on it in the order listed:
 - 1. The utility meter can and meter w/necessary CT enclosure shall be located as the first device downstream of the utility connection.
 - 2. A three-pole service disconnect/ overcurrent protection device with insulated neutral bus shall be installed after the metering and utility company monitoring device(s) (i.e. enclosed circuit breaker). This breaker shall be coordinated with the utility voltage and current service supplied to the pumping station. The enclosure for this breaker shall be rated as NEMA 3R or NEMA 4X and shall be a UL approved service disconnecting device which may be pad-locked in the "OFF" position.
 - 3. This enclosure shall be equipped with an appropriate earth ground bonding-to-utility-neutral bonding capability which meets or exceeds the requirements of NFPA 70. U.L. listed for service entrance application.

4.05 WARRANTY

Conflict of the warranty requirements of this specification may exist for some sub-systems as described in specification sections 16000, 16400, 16482 and 16620. Where such conflicts exist, the provisions of the cited sections shall govern.

- A. Warrant at 100% all parts and labor for one (1) year that covers normal wear and tear for typical sewage pump applications.
- B. The pump manufacturer shall provide a comprehensive warranty for one year (12 months) from the date of acceptance of the pump station by the City for operation and maintenance. For years 2 – 5 of the service contract, the manufacturer shall provide warranty work on a pro-rated basis. A manufacturer's service representative and the Conveyance and Distribution Director or designee shall work together to make joint resolutions of all warranty work, as well as, all other maintenance needs. The manufacturer shall also provide a service representative authorized by the pump manufacturer. Any work carried out by the authorized representative shall not violate manufacturer's warranty.
- C. A four-hour response to service call by the City shall be provided by the service representative. The service representative shall restore pump to service within five (5) working days.
- D. Service Manual – The pump manufacturer shall furnish the Owner with a minimum of six (6) service manuals for the pumps installed.
- E. The pump manufacturer shall provide the identification of manufacturer's contact person and cell phone / pager number and an alternate name and phone number for 24-hour availability.

4.06 ACCEPTANCE OF PORTIONS OF THE WORK

- A. The employment of contractor installed, owned, operated, and monitored station bypass pumping system(s) for actual sewer water shall not be permitted to be deactivated or taken "off-line" prior to full acceptance of the station pumping systems' demonstrated ability to operate completely in the automatic mode and to provide required alarms to the normal City of Savannah remote monitoring facilities. This demonstration shall be accomplished to the complete satisfaction of the Engineer or his/her Inspector as well as the City of Savannah maintenance department that shall assume maintenance/operations responsibility for the accepted portions of the station. Partial and/or final acceptance of the work completed shall be predicated upon meeting the applicable specification and demonstrating the operational capabilities of that portion of the pumping station as defined by this section of the specifications and specification sections 16000, 16400, 16482 and 16620 as applicable. In the event that this section differs from sections 16000, 16400, 16482 and 16620, the

provisions of the cited sections shall govern.

- B. The Owner reserves the right to accept and use any portion of the work whenever it is considered to be in his/her best interest to do so. The City's Engineer or his Inspector shall have the authority to accept or reject any portion of the work prior to final acceptance.
- C. The Contractor shall complete the Lift Station Data sheets (5) included in this section fully prior to the Owner's acceptance.
- D. During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the owner's personnel.

4.07 ELECTRICAL INSPECTIONS AND ACCEPTANCE

- A. The Contractor shall coordinate with all entities (City of Savannah witnesses, manufacturer representatives, and, etc.) in order to schedule their presence at the project site as required in the project specifications. This coordination responsibility assignment shall apply to partial, in-process, and final-acceptance inspections and manufacturer support activities throughout the entire project.
- B. Acceptance inspections (partial or full) shall not be acceptable unless requisite technical drawings and maintenance/troubleshooting guides are provided to the actual maintenance activity which will become responsible for operating and maintaining the accepted portion of the work prior to relieving the Contractor of such responsibility. "Mark-UP" copies of drawings and instruction books shall be acceptable for partial / "in-Process" acceptance. Final "As-Built" drawings shall be required for all final acceptance inspections.
- C. Electrical / Electronic Systems Inspections: All electrical/electronic equipment/system(s) acceptance inspections shall be as specified in this document AND in the four (4) specification sections 16000, 16400, 16482 and 16620 of the City of Savannah Standard Specifications found on the City of Savannah website relating to sewer and wastewater collection and conveyance.

PART 5 - SUBMERSIBLE PUMP STATION CONTROLS

5.01 ACCEPTABLE MANUFACTURERS

The pump station control panel shall be provided as part of the pump package. Equipment shall be furnished by ITT/Xylem/Flygt. No substitutions permitted.

5.02 PURPOSE

Pump station control systems shall serve the function of controlling the level of the raw sewage in the station wet well by way of starting, running, and stopping the

station pumps in order to move the influent sewage from the wet well to the designated Water Quality Control Sewer Treatment Plant via the force main piping. The controls shall be capable of fully unattended automatic operation as well as manual (attended) operation of the pumping and monitoring systems at the station. The pump controls shall also serve as the primary origination of and routing interface of all remote and local alarm and status monitoring functions related to the SCADA as well as the auto-dialer sub-systems at the station. The controls shall also provide a means of monitoring the primary power and acting to prevent damage to pump motors and/or incorrect operation of the station due to single phasing, reverse phase rotation, loss-of-phase, and "brown-out" conditions of the primary power source as well as to provide an alarm signal to the SCADA and Auto-Dialer sub-systems.

5.03 RELATED DOCUMENTS

The below listed documents shall be used in conjunction with this specification. In the event of conflict between the requirements of this document and the related documents and/or additional requirements outlined in this document, the cited sections shall govern.

- A. Specification Section 16000
- B. Specification Section 16400
- C. Specification Section 16482
- D. Specification Section 16620

The most current revision at the time of project approval shall apply. Specification revisions become official once posted on the City of Savannah web site.

5.04 SUBMITTALS

Submittals shall be provided as specified in the Contract Documents.

PART 6 – CONTROL DESCRIPTION

6.01 AUTOMATIC LEVEL CONTROL SUB-SYSTEM

- A. The automatic level control system shall be one of the types listed below and shall be considered the "heart" of the Automatic Control System.
 - 1. Siemens/Milltronics Hydroranger 200 with ultrasonic transducer level sensing.
 - 2. Multi-smart control with (as applicable) ultrasonic transducer or multitrode probe level sensing, (consult with local Xylem/Flygt representative for detailed information).
 - 3. Alternating relay with wet well float switch sensing.

- B. All level control system(s) sensor devices shall be suspended/hanging in the wet well by their own cables inside the wet well such that the opening/closing of the wet well hatch does not vary their physical location in any way.
- C. All automatic level control systems shall have an additional float switch suspended in the wet well designated as the high level sensor which shall be incorporated into the station level control sub-system such that it will activate the "Fail Safe" function described elsewhere in this specification. This float switch shall hang in the wet well by its own cable inside the wet well such that opening the wet well hatch does not vary its physical location in any way.
- D. An additional float switch shall be located inside the wet well designated as "low level all pumps off" if shown in the electrical drawing. If present, this float switch shall comply with all the requirements for suspending, securing, and locating as described above.
- E. Only 24VAC current limited control voltage power shall be permitted for use in the wet well.
- F. No other automatic level control system shall be acceptable unless specified in writing by the Electrical Engineer with the concurrence of the wastewater conveyance maintenance superintendent and noted on the electrical drawings as a variance to the Standard Specifications.

6.02 PUMPING STATION CONTROL CHARACTERISTICS

- A. Pumping Stations with 49 HP and smaller pumps shall have one Master Control Panel including but not limited to the following functions/components/attributes:
 1. Three-pole thermal-magnetic circuit breakers for primary power removal from pump motor starters and drives, (one for each pump).
 2. Motor starter/drives with associated control circuitry for the station pumps.
 3. Single-pole 120VAC circuit breakers as listed below:

a. Control Circuit	20 AMP	1 each
b. Alarm Dialer Power	20 AMP	1 each
c. SCADA Panel Power	20 AMP	1 each
d. Generator Battery Charger	20 AMP	1 each
e. Yard/area Lighting	20 AMP	1 each
f. Convenience Receptacles	20 AMP	1 each
g. Generator jacket heater	20 AMP	1 each (2-pole)
h. Spare breakers	20 AMP	2 each
i. Spare breaker	30 AMP	1 each (2-pole)
 4. One each two-pole circuit breaker for input to an externally mounted single-phase transformer for 480 VAC to 120/240 VAC conversion, (applies to stations with primary feed voltage of 480 VAC only). Current rating is to be as shown on the electrical drawing.

5. One each two-pole circuit breaker for output of the transformer cited in "4" above. Add for generator jacket heater larger than 1500W.
6. Power Distribution Block(s) for main system power in (3-Phase plus Neutral as required) and follow-on distribution within and external to the panel.
7. UL approved ground lugs for equipment grounding conductors.
8. Automatic Level Control System less the portion which resides in the wet well.
9. Local alarm (visual and audio) system control/activation/silence system less the portion which is located outside the panel.
10. Pump Motor starter/drive systems.
11. Terminal strip(s) for wiring which is external to the panel for 120 VAC distribution and for control, status, and alarm functions external to the panel as required, (these terminal strips shall not be located within the panel in such a way as to require stooping low or kneeling on the ground in order to view or access them).
12. All circuitry devices required to generate or route command and control as well as monitoring signals into/out of the panel. The electrical drawing shall show all of the required devices and wiring necessary for the Master Control to perform as required in the above paragraphs.

- B. Pumping Stations with pumps 50 HP and larger will usually have the control system housed in a building structure on the lift station property. This Control Room shall contain all the controls, pump motor starters/drives, primary power distribution, SCADA system, Auto-Dialer system, and interconnecting wire ways and wiring for station operation except for those portion(s) required to provide interface panels, junction boxes, and etc. to include main utility power metering and isolation devices located outdoors. The Control Room shall house a Station Control System with appropriate control and monitoring capabilities and in appropriate enclosures, as listed below and at a minimum:

(Equipment located outdoors shall be mounted as described in Standard Specification Section 11100, paragraph 4.02).

1. A station master level control system which shall provide automatic command and control of the station pump starter/drive control sub-system(s).
2. As part of the master level control sub-system, a capability of wiring interface (terminal boards) between the master control and the SCADA, Auto-Dialer, wet well sensing devices, Automatic Transfer Switch position sensing, condition sensing of the pump controls, and "Fail-Safe" control and local alarm activation with audio silencing function.
3. As part of the master level control sub-system, Flygt/Xylem MAS and CAS monitoring devices and interface terminals for routing "GO – NO GO" control commands to the pump control/protection sub-system(s) as required.
4. As part of the master level control sub-system, a phase monitoring capability which shall provide a "GO – NO GO" command to each pump control sub-system

in order to preclude motor damage due to “single-phasing” conditions and incorrect rotation direction of the pump motors/impellers.

5. A station primary power distribution system which shall allow the 100% isolation of power from one individual pump control system at a time with NO EFFECT on any of the others so that the station may continue to perform its primary function albeit with one less pump on-line. An “I-Line” style power distribution system is preferred.
6. An Alarm Dialer to send alarm calls via cellular network to the City of Savannah remote monitoring facilities. These alarms shall be appropriately interfaced (wired) between the Dialer device and the appropriate “dry contact” terminals associated with the conditions listed below:
 - a. High Wet Well Level
 - b. Loss of correct three-phase power conditions
 - c. At least one pump or pump control is in a “failure” condition
 - d. The station Automatic Transfer Switch (Load side) is connected to the Emergency Power System generator power source
7. A Emerson (Bristol) Process Management “Controlwave” control and monitor panel correctly interfaced with all other sub-systems terminals/connection points for all required digital input signals, analog (4 – 20ma) signals and the 120 VAC power distribution sub-system, (NOTE: 4–20 mA signal wiring shall not be routed by way of intermediate terminal board connections, wiring shall be routed directly from device to device).
8. A separate pump starter/drive assembly with Hand-Off-Auto (HOA) control switch, Pump Run elapsed time meter display (as required), a pump starter/drive control “RESET” function, a “Select Starter/Drive” function if the pump control is designed with both VFD and back-up starter equipment for each station pump.
9. Each pump starter/drive assembly shall have the following capabilities/sub-systems as a minimum:
 - a. A transformer which shall convert the primary power voltage to 120 VAC which shall function as an independent control power source for that control. This power source shall be interfaced (wired into) with the phase monitoring sub-system located in the master level control cabinet. The input and output of this transformer shall be fused as required by NFPA 70.
 - b. A transformer which shall be fed from the 120 VAC source cited above and producing 24VAC power shall serve as the power source for individual pump accessory devices such as a Flygt MAS unit as applicable. This transformer shall be fused in accordance with NFPA 70.
 - c. All necessary VFD drives and/or Reduced Voltage Soft Starters (RVSS) along with applicable contactor assemblies necessary to select/connect the applicable starter/drive to the pump assembly. Note: RVSS devices shall be designed and wired in the “Non-Reversing Shorting Contactor” configuration in order to prolong the service life of the soft starter device.

- d. All necessary relays and other devices to include terminal board(s) necessary to distribute power, control, and monitoring signals within the control as well as for interfacing with external sub-systems.
 - e. The use of "wire nuts" or other similar devices to make wire joints/connection shall not be acceptable.
 - 10. A transformer and load center sub-system designed to produce and distribute 120/240 VAC power to lighting circuits, convenience receptacles, environmental control systems (heat pump/air conditioner), and sub-assemblies which do not generate their own internal 120/240VAC power from the station primary power system. This load center shall be UL approved and capable of providing all non-internally generated power required by various devices, and shall have appropriately sized circuit breakers in sufficient quantity to service all required loads plus two (2) spare single-pole 20 AMP 120VAC and one spare 30 AMP double pole 240VAC circuit breakers. The load center and transformer shall be incorporated into an "MCC" type enclosure/ system or shall be configured as a floor-mounted transformer and surface-mounted load center system. Load centers which are mounted into "hollow" walls similar to that normally used in residences shall not be acceptable.
 - 11. All enclosures/devices shall be industrial grade devices with UL approval and shall conform to the requirements of NFPA 70.
- C. A "Fail-Safe" control circuit which shall assume control of "pump-on" and "pump-off" functions bypassing the normal automatic level control sub-system in the event of the failure of that sub-system to exercise control. This function shall be designed such that it operates between the "high level" and "high-high" level in the wet well and activates the "high level" alarm to SCADA, Alarm-Dialer, and local (horn and strobe) devices for as long as the condition exists.
- D. Pumping stations which must be "custom" designed due to unusual characteristics such as the available utility power being other than 480VAC or 240VAC or single-phase as opposed to three-phase shall follow the general guidelines as discussed above with appropriate additional features as necessary to control 480/240VAC pumps. Since such stations are few in number, each design shall be created with the Project Electrical Engineer consultant and the Wastewater Conveyance Department working in close cooperation for each design in order to produce an operationally and cost effective end result.
- E. Equipment assemblies/panels located out of doors shall follow the guidelines listed below:
- 1. There shall not be any equipment other than lighting fixtures, convenience receptacles, conduit entry/exit devices, and necessary environmental (air conditioning/heat pump) equipment attached to or mounted on any building structure located on the station property. Appropriate backboard assemblies shall be utilized for mounting of these devices. These backboard(s) shall be

- located as determined by the contract drawings. Mount all equipment on unistrut channels.
2. Equipment enclosures/equipment shall be rated a minimum of NEMA 3R or better.
 3. Outdoor equipment shall include but not be limited to:
 - a. Utility company connection point device(s)
 - b. Utility power metering and monitoring equipment
 - c. Utility power disconnect/isolation switch device(s)
 - d. Utility utility power main breaker device(s)
 - e. The complete Emergency Standby Power system to include generator set, skid-base fuel tank, and automatic transfer switch, (the generator and fuel tank shall be installed on an appropriately designed concrete mounting pad)
 - f. Enclosures containing junction/connection points for all electrical equipment located in/at the station wet well
 - g. Outdoor area lighting
 - h. Outdoor convenience receptacle(s)

PART 7 – TESTING, INSPECTION, AND FINAL ACCEPTANCE

7.01 EQUIPMENT START-UP/PROGRAMMING

- A. The Contractor shall coordinate as necessary to retain the technical services of factory certified personnel to verify that sub-assemblies such as RVSS, VFD, and other devices are correctly installed, programmed per end-user requirements, and acceptable for warranty purposes.
- B. The equipment systems and sub-systems operational capabilities shall be demonstrated at the operational site to the satisfaction of the Inspector or his/her representative as well as the Wastewater Conveyance Maintenance Superintendent or his/her representative(s).

7.02 DOCUMENTATION AND END-USER O&M PERSONNEL TRAINING

- A. A minimum of one copy of applicable operating and maintenance instructions shall be provided to the Wastewater Conveyance Maintenance Superintendent or his/her representative in printed form as part of the final acceptance procedures/inspection(s), and one PDF (electronic) copy on compact disk.
- B. A minimum of copy of blueprints, installation notes/mark-ups, and interconnection drawings utilized to build the station electrical system(s) shall be provided to the Wastewater Conveyance Maintenance Superintendent or his/her representative at the time of the final acceptance inspection, and one PDF (electronic) copy on compact disk.

- C. A minimum of copy of applicable “as built” drawings related to the interior wiring of items such as the Master Level Control Panel and Pump Control assemblies shall be provided to the Wastewater Conveyance Maintenance Superintendent or his/her representative prior to the acceptance of operational or maintenance responsibilities for the station by the applicable department of the City of Savannah, and one PDF (electronic) copy on compact disk.
- D. The Contractor shall coordinate with all applicable vendors and the City of Savannah Wastewater Conveyance Maintenance Superintendent to schedule and provide operation and maintenance training of city personnel on site.

PART 8 – WARRANTY

Warranty provisions shall be as described in Specification 11100 and 16620.

END OF SECTION 11100

INDEX TO
SECTION 16000
WIRES AND CONDUITS

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SECTION 16000

WIRES AND CONDUITS

PART 1 – GENERAL

1.01 SCOPE

- A. This section describes the requirements for acceptable installations of wire, conduit, wire ways and conduit assemblies which are not described in the related documents listed in this document.
- B. The standards of NFPA 70 (National Electrical Code), IEEE, and NEMA; along with all local and state requirements shall, as applicable, be modified to conform to the specific needs of the City of Savannah Wastewater Conveyance Department. Such modifications shall be to adjust the requirements to a more stringent level. The requirements of the standards shall not be reduced in any way by the requirements of this document.

1.02 CODES AND PERMITS

All electrically related work, installations, equipment, and devices shall conform to the requirements of the following listed standards as a minimum. The electrical design engineer shall be permitted to increase/enhance the requirements but SHALL NOT be permitted to decrease/reduce these requirements.

- A. NFPA 70 National Electrical Code
- B. NEMA Standards Publication 250-2008
- C. Local utility company standards and installation guidelines with respect to service entrance and metering

1.03 RELATED DOCUMENTS

The below listed documents shall be used in conjunction with this section. In the event of conflict between the requirements of this document and the related documents; this specification document shall govern.

- A. Specification Section 11100
- B. Specification Section 16400
- C. Specification Section 16482
- D. Specification Section 16620

The most current revision at the time of project approval shall apply. Specification revisions become official once posted on the City of Savannah web site.

1.04 SUBMITTALS

The below listed drawings and product data, as applicable, shall be submitted:

- A. Equipment outline drawings showing elevation, plan, and interior views, weight, cable/wire entry points, and mounting bolt patterns.
- B. Device specifications to include performance data and code compliance certification information related to NFPA 70, IEEE Standards, and IEC/EN Standards.
- C. Dimensional and location "maps" of conduit wire ways routed concealed within walls or below grade.

1.05 QUALITY ASSURANCE AND PRODUCT TECHNICAL SUPPORT

- A. All devices shall be newly manufactured and of the most recent production model which meets or exceeds the performance requirements of this specification.
- B. All products shall be UL approved for their application requirements, installation location, and installed in compliance with NFPA 70 and IEEE Standards.

PART 2 – PRODUCT DESCRIPTION

2.01 ELECTRICAL WIRE AND WIRING

- A. Shall be 90°C copper stranded THHN/ THWN/ THEN2; rated for use at 600VAC or lower voltage as described in NFPA 70 Article 310 and shall meet or exceed all associated specifications therein to include construction details, insulation jacket, ampere capacity, physical dimensions/diameters, and allowable location(s) for installation.
- B. All equipment grounding conductors shall have a green insulation jacket and shall conform to the standards of NFPA 70 Article 200 and 250. Green insulation jacketed conductors shall not be utilized for any purpose other than grounding.
- C. Shielded wiring conductors/cables shall be installed in accordance with NFPA 70 and IEEE standards associated with electrical "noise" and EMI interference elimination/reduction for all interconnecting wiring susceptible to such interference as shown on the contract electrical drawings.
- D. All shielded wiring shall be kept to the shortest length possible and shall be continuous from origination point to termination point. Shielded wire shall not be spliced.

- E. All wiring conductors sized AWG-8 or smaller shall be marked for identification with unique identification numbers and/or letters at both ends. Products of Ideal (Wire Marker Rolls or Wire Marker Booklets) are acceptable.
- F. Power distribution (load current carrying) conductors shall have color coded insulation as shown below. Conductors of AWG-4 or larger shall be acceptable with standard black insulation jackets providing they are clearly marked at both ends with colored "phasing" tape in the appropriate color.

277/480VAC – Phase A -----Brown
 277/480VAC – Phase B -----Orange
 277/480VAC – Phase C -----Yellow
 277/480VAC – Neutral -----Gray

115/208VAC – Phase A -----Black
 115/208VAC – Phase B -----Red
 115/208VAC – Phase C -----Blue
 115/208VAC – Neutral -----White

120/240VAC – Phase A -----Black
 120/240VAC – Phase B -----Orange (High Leg)
 120/240VAC – Phase C -----Red
 120/240VAC – Neutral -----White
 (NOTE: "High Leg" shall be identified with Orange over Red color coding)

2.02 ELECTRICAL CONDUIT / RACEWAY AND WIRE WAYS

All conduit raceway and/or wire-ways shall conform the requirements of NFPA 70, UL, and NEMA standards, as applicable, with the additional requirements as listed below:

- A. All conduit installed outdoors and above grade shall be Rigid Aluminum.
- B. All conduit installed below ground shall be Rigid Schedule 80 PVC.
- C. Minimum conduit size shall be ¾".
- D. Where flexible conduit is required by system installations such as the Emergency Power System, it shall be of metallic liquid-tight style. Non-metallic liquid-tight style flexible conduit such as "Carflex" is not permitted.
- E. Outdoor penetrations of enclosures or equipment housings for conduit entry shall be made with Meyers Hub or threaded hubs.

- F. Penetrations of building/wet well structures shall be made with water tight devices and/or techniques. Provide high strength grout or link seal.
- G. Where aluminum conduit devices penetrate concrete, brick, cinder block, or other such materials they shall be installed with corrosion protection and the penetration area shall be restored to its original water-tight integrity. Corrosion protection shall be two coats of 3M Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex 1100 Type. Provide high strength grout or link seal.
- H. All PVC conduit and conduit fittings which are exposed to sunlight shall be painted with two (2) coats of outdoor rated paint. Apply on coat of Rust-Oleum Plastic Primer (SKU 249323) and one coat of Rust-Oleum Specialty Paint for Plastic, Shell White (SKU 211364).
- I. Outdoor installations shall only penetrate the bottom or side of the enclosures. Top and side penetrations not permitted.
- J. Indoor conduit installations shall be made utilizing metallic EMT type conduit and steel compression fittings which shall meet or exceed the standard NEMA 1.
- K. Service grounding shall be provided in accordance with the National Electrical Code, NFPA 70. Bond the neutral at the service disconnect, provide a bonding jumper and extend a grounding electrode conductor in Sch.80 PVC conduit to the grounding delta.
- L. All branch circuit feeder and circuit conduits shall be provided with a green insulated equipment grounding conductor. Use of the raceway as a grounding path will not be accepted or approved.
- M. Bond all metal enclosures, equipment frames, hoist frames and other metal parts of the pump station. Provide, where necessary, metal braid bonding jumpers between steel structures.

PART 3 – TESTING, INSPECTION, AND FINAL ACCEPTANCE

3.01 EQUIPMENT START-UP / PROGRAMMING

- A. The Contractor shall coordinate as necessary to retain the technical services of factory certified personnel to ensure that all assemblies/sub-assemblies are correctly installed, programmed per end-user requirements, and acceptable for commissioning for warranty purposes.
- B. The equipment systems and sub-systems operational capabilities shall be demonstrated at the operational site to the satisfaction of the Inspector or his/her representative as well as to the Wastewater Conveyance Maintenance Superintendent or his/her representative.

3.02 DOCUMENTATION AND END-USER OPERATING AND MAINTENANCE TRAINING

- A. A minimum of one (1) copy of applicable operating and maintenance instructions shall be provided in printed form to the Wastewater Conveyance Department Maintenance Superintendent or his/her representative in printed form as an integral part of the final acceptance.
- B. The Contractor shall coordinate with all applicable vendors and the City of Savannah Wastewater Conveyance Department Maintenance Superintendent to schedule and provide on-site operating and maintenance training for City of Savannah personnel.

PART 4 – WARRANTY

Warranty provisions shall be as described in Specification 11100 as supplemented in this document.

END OF SECTION 16000

INDEX TO
SECTION 16400
SCADA SYSTEM COMMUNICATION AND MISC. INSTRUMENTS

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SECTION 16400

SCADA SYSTEM COMMUNICATION AND MISC. INSTRUMENTS

PART 1 – GENERAL

1.01 PURPOSE

Pump station SCADA, alarm dialers, and flow meters are used for control of the pump station, communication of the alarms, and recording of flow data such that the reliability of the pump station and overall sewage collection system is ensured.

1.02 RELATED DOCUMENTS

The below listed documents shall be used in conjunction with this section. In the event of conflict between the requirements of this document and the related documents; this specification document shall govern.

- A. Specification Section 11110
- B. Specification Section 16000
- C. Specification Section 16482
- D. Specification Section 16620

The most current revision at the time of project approval shall apply. Specification revisions become official once posted on the City of Savannah web site.

1.03 SUBMITTALS

A. SCADA System

1. Provide a complete submittal package for evaluation by the owner. The following list, as a minimum, shall be submitted for review.
 - i. Descriptions of equipment and services to be provided
 - ii. List of equipment.
 - iii. Results of radio path study
 - iv. Detail drawings of the panel layout: SCADA cabinet with RTU and associated equipment, include field wiring terminations
 - v. Warranty
 - vi. Antenna, cable and all fittings and connectors

B. Cellular Dialer

1. Provide a complete submittal package for evaluation by the owner. The following list, as a minimum, shall be submitted for review.

- i. Description of the equipment to be provided
- ii. Manufacturer cut sheets of the cellular dialer, enclosure, and remote antenna (as required).
- iii. Service contract
- iv. Warranty

C. Flow Measurement Equipment

1. Provide a complete submittal package for evaluation by the owner. The following list, as a minimum, shall be submitted for review.

- i. Description of the equipment to be provided
- ii. Manufacturer cut sheets of the flow meter
- iii. Installation instructions and programming
- iv. Warranty

PART 2 - PRODUCTS

2.01 SCADA REMOTE TERMINAL UNIT (RTU) DEVICES

A. SCADA RTU for ALL Stations (Duplex, Triplex, Variable Frequency Drive):

Controlwave MicroEnc with Modular input/output (I/O), 150 Mhz CPU, 1-Enet, 2- Rs232, 1-Rs485, (32) Digital Inputs points w/ remote termination, (16) Digital output points w/remote termination, (16) Analog Input points w/ Remote termination, (4) Analog output points w/ remote termination. The SCADA unit shall be supplied as a complete unit including a Microwave Data Systems (MDS) SD9 900MHz Radio with 9600bps modem Rs-232, with network wide diagnostics option.

B. Antenna:

Antenna - The antenna shall be 10DB Gain YAGI antenna and shall be furnished complete with all mounting hardware necessary for mounting to a 2" dia. mast (the 10DB Gain YAGI antenna is included in Bristol Babcock's standard duplex and triplex quote/price). Antenna shall be furnished such that the only field connection required by

the Contractor shall be the antenna cable by means of a Type-N male connector. Because the antenna height and Azimuth are site specific it shall be the responsibility of the contractor to obtain the services of a qualified radio system firm to determine proper height and direction of antenna placement. Antenna shall be mounted in accordance with City of Savannah Standard Detail S-18 as applicable. The results of the radio path study, which shall be performed to determine the required antenna height and orientation, shall be submitted to the Owner for approval prior to installation of any equipment. Detail necessary for installation.

C. Radio Path Survey:

Radio Path Study Form, provided below, shall be faxed to the City of Savannah Radio Shop (912-351-3443) and emailed to jeff_jones@savannahga.gov for a determination of height and repeater choice. Contractor shall hire Savannah Communications, contact Harold Miller or Randy Riggan, 912-964-1479 to perform radio path study.

D. SCADA REMOTE TERMINAL UNIT (RTU) STARTUP / TEST

1. The contractor shall provide for complete check out of the SCADA system by the SCADA RTU supplier. This shall include the field wiring, start-up, proper operator of the RTU, interface with field transmitters and control cabinet, the antenna installation, and verification of proper radio operation by the SCADA RTU supplier. The contractor shall provide a certificate of verification to the City of Savannah and signed by the supplier that the unit has been field verified as described above and that the unit will perform as intended under this specification.
2. Antenna: The City of Savannah at start-up will conduct an inspection of installation of Antenna to include the following:
 - i. Mounting (Proper hardware)
 - ii. Grounding (Proper Grounding Techniques, Cad-welding)
 - iii. Cable Installation (Proper Cable Hanger Clips, Proper Spacing of Cable Hangers, SWR, Reflective Power)
 - iv. Signal Strength (Min -88)
 - v. Connector End installation (Weather Proofing)

Any problems found by Radio Shop personnel will require immediate action to fix and station will not be allowed to pass inspection until problems are fixed and verified by Radio Shop personnel.

Radio Path Study

Site: _____

Site Coordinates: _____

Date: _____

Technician: _____

Contractor: _____

Survey Results

	Kerry Street N32 02'29.1" W081 04'24.2" 952.39375	South Side N31 56'33.3" W081 07'19.4" 952.08125	West Side N32 04'51.1" W081 15'12.2" 952.28125	Kerry MDS N32 02'29.1" W081 04'24.2" 941.29375
Magnetic				
Statute Miles				
10'				
20'				
30'				
40'				
50'				
60'				
Other				

FILL IN ALL BLOCKS

Comments: _____

2.02 CELLULAR ALARM RTU (Auto Dialer):

A. Equipment Identification:

1. The cellular auto-dialer shall be a Mission Communications Model 110/800 family series unit with Analog Input Option Board, PN 466 in the Mission Communications standard NEMA 1 enclosure with applicable transformer, battery pack, and antenna with mounting accessories.
2. The enclosure for the sub-system shall be rated a minimum of NEMA 3R and shall be a Stahlin Part # J1816HPL enclosure with a Stahlin Part # BP-1816CS backplane.
3. A Thomas & Betts (Steel City) utility box P/N 58371 ¾ with NEMA 5-20 R configured receptacle and Part # 58 C 7 cover for 120 VAC power.
4. All signal/sensing wiring to/from the cellular unit shall be Belden P/N 9316A shielded pair wire.
5. Substitute or "as equal" equipment/material shall not be acceptable.

B. Equipment Installation:

1. The mission unit less the antenna components shall be mounted inside the NEMA 3R enclosure using #8-32 machine screws. The enclosure shall also have the 5-20 R configured receptacle mounted inside of it. The antenna and mount shall be located externally to and higher than the NEMA 3R enclosure such that the cellular signal is not obstructed.
2. The entire assembly shall be securely mounted to its supporting structure as described in Specification Section 11100 and Detail # S19A as applicable.
3. All signal/sensing wiring inside the enclosure shall be terminated by City of Savannah technical personnel. Shield "drain" wires shall not be terminated to ground outside of the enclosure.
4. The cellular alarm RTU assembly shall monitor, report, and/or alarm on the following points as applicable to the individual station:
 - a) Wet Well High Level alarm
 - b) Phase failure/loss of utility alarm

- c) Motor Fail Alarm – Pump #1
 - d) Motor Fail Alarm – Pump #2
 - e) Motor Fail Alarm – Pump #3
 - f) Motor Fail Alarm – Pump #4
 - g) Generator is “On-Line” alarm
 - h) Wet Well Level (4-20ma)
 - i) Pump #1 running AMPS (4-20ma)
 - j) Pump #2 running AMPS (4-20ma)
 - k) Pump #3 running AMPS (4-20ma)
 - l) Pump #4 running AMPS (4-20ma)
 - m) Flow Meter (pulse)
 - n) Rain Gauge (pulse)
5. Programming and activation of the cellular dialer shall be accomplished by City of Savannah Wastewater Conveyance Department technical personnel during the final phases of acceptance inspections related to it.

2.03 FLOW MEASUREMENT EQUIPMENT

A. Meter

1. The flow meter shall be of the magnetic type and provide for transmitting of flow in full pipes. The flow meter shall be obstruction free and installed between two pipe flanges having the same nominal diameter as the flow meter end connections. The flow meter shall operate by means of pulsed DC coil excitation and shall not require zero reset. The flow tube shall be constructed of type 304 stainless steel, the liner shall be Neoprene and the sensor electrodes and the grounding electrodes shall be stainless steel type 316. Flow tube end connection shall be 150# ANSI steel flanges. The flow tube shall be able to withstand up to 30 feet submersion for 20 years.
2. The external surface of the sensor shall be protected by corrosion resistant two component paint. The sensor shall be pressure tested to 2.5 times the nominal pressure. The sensor shall be manufactured by an ISO 9001 approved company and shall be Siemens/Danfoss Model MAG 3100/6000 or equal. Sensor shall be supplied with appropriate length of signal cable.
3. If a grounding ring is required, it shall be 316 Stainless Steel and installed at the inlet flange to assure potential equalization.

B. Signal Converter/Indicator and Totalizer

1. The converter shall be suitable for remotely mounting up to 1,000 feet from the sensor. The converter shall be supplied with its own dedicated 120VAC, 60 Hz power source at the station. The power consumption shall not exceed 10 VA.
2. The converter shall provide a 4-20ma isolated output proportional to flow. In addition a frequency/pulse output and a relay output shall be provided by the converter. The frequency output shall be proportional to flow rate and shall be capable of being scaled from 0-10 KHz. The pulse output shall be capable of being scaled for remote totalization.
3. The converter shall have an LCD display showing actual flow in GPM and totalized flow in Gallons. The LCD display shall have at least 2 x 16 alphanumeric digits and be back-lit. The units shall be field programmable and configurable. The units are to be field full scale configurable (exchange from 150 full scale to 300 full scale). The keyboard and display shall be rotatable so that the flow rate and totalized flow can be seen independent of sensor orientation. The converter shall be suitable for bi-directional flow, reading flow rate in both forward and reverse directions and containing two internal counters for totalized flow in both directions.
4. The converter shall be provided with an automatic zero point setting, an auto-range function and an empty pipe cut-off.
5. The converter shall be capable of detecting the following fault conditions:
 - a) Loss of current to the coil circuit
 - b) Loss of load on the current output
 - c) Empty pipe
6. The converter shall be provided with an error log where all fault conditions occurring within 180-day period are stored.
7. The converter shall be a plug-in module, immediately replaceable without the need of disconnecting cables or recalibration.
8. The signal converter shall be manufactured by an ISO 9001 approved company.

9. The flow accuracy on the electronics of the magnetic meter shall be within 0.25% of reading flow accuracy of 0.10% of rate. The magnetic flow-meter shall be Siemens/Danfoss Model MAG 3100/6000 or equal.

C. Execution

1. All components shall be located, (minimum runs of straight pipe upstream and downstream, full pipe flow conditions, etc.), installed and tested in accordance with the manufacturer's written instructions.
2. All component parts/sub-systems shall be located outdoors and, where applicable, contained in a readily accessible enclosure which is rated a minimum of NEMA 3R. Appropriate conduit(s) and wiring shall be installed for power and monitoring signals to be installed into/out-of the system for correct operation.

- D. Warranty: All components shall be warranted one year from the final acceptance of the system.

END OF SECTION 16400

INDEX TO
SECTION 16482
PUMP MOTOR STARTERS AND DRIVES

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SECTION 16482

PUMP MOTOR STARTERS AND DRIVES

PART 1 – GENERAL

1.01 GENERAL

- A. Pump motor starters and pump motor drive sub-system(s) shall be three pole devices which, as part of the station pump control system, shall be designed to connect the pump primary power source to the pump main power leads when it is necessary to run the pump and to remove that power when it is necessary for the pump to stop running.
- B. These sub-systems are defined as across- the- line (ACL), variable speed drive (VFD), or reduced voltage solid state (RVSS) starters. These devices shall be one of the following types as shown in the Contract Drawing(s):
 - 1. NEMA STANDARD contactor style with 120VAC start/stop command and control (ACL).
 - 2. Solid state ramping voltage and current style starters (RVSS).
 - 3. Solid state variable motor speed control style starter/ run device (VFD).
- C. Autotransformer type reduced voltage starters are not acceptable.
- D. The only power source(s) that any of these starter devices shall require for proper operation shall be the associated pump motor main power and a single phase 120VAC control power source. Any starter device which requires any other separate power source(s) for command and control or I/O logic functions to operate correctly are not be acceptable.

1.02 CODES AND PERMITS

All electrically related work, installations, equipment, and devices shall conform to the requirements of the following listed standards as a minimum. The electrical design engineer shall be permitted to increase/enhance the requirements but SHALL NOT decrease/reduce these requirements.

- A. NFPA 70 National Electrical Code
- B. NEMA Standards Publication 250-2008
- C. Local utility company standards and installation guidelines with respect to service entrance and metering

1.03 RELATED DOCUMENTS

The below listed documents shall be used in conjunction with this section. In the event of conflict between the requirements of this document and the related documents and/or additional requirements outlined in this document; this specification document shall govern.

1. Specification Section 11100
2. Specification Section 16000
3. Specification Section 16400
4. Specification Section 16620

The most current revision at the time of project approval shall apply. Specification revisions become official once posted on the City of Savannah web site.

1.04 SUBMITTALS

The below listed shop drawings and product data shall be submitted:

- A. Equipment outline drawings showing elevation, plan, and interior views, weight, cable/wire entry points, and mounting bolt patterns.
- B. Power and control schematics to include external connections and wire terminal identification markings.
- C. Device specifications to include performance data and code compliance certification information related to NFPA 70, IEEE Standards, and IEC/EN Standards.

1.05 QUALITY ASSURANCE AND PRODUCT TECHNICAL SUPPORT

- A. All devices shall be the manufacturer's most recent production model which meets the performance requirements of this specification.
- B. The product selected for installation shall have a parts and factory certified service organization located within 250 miles of the project location. Contractor shall provide the name and address of this factory certified service and parts organization to the Wastewater Conveyance Maintenance Superintendent.
- C. All equipment shall be UL approved and be installed in compliance with NFPA 70 and IEEE Standards.

PART 2 - EQUIPMENT DESCRIPTION

2.01 ACROSS THE LINE (ACL) MOTOR STARTERS

- A. The starter shall be a NEMA AC Magnetic Starter assembly with the features listed below:
1. A 120VAC coil
 2. An integrated solid state overload protection assembly appropriately sized for the motors installed. This assembly shall be resettable by means of pushing a non-conductive push-rod mechanism which resets all three phase lines simultaneously.
 3. Provide Square D Te Sys T motor management system.
 4. The assembly shall be equipped with alarm contacts (one normally open and one normally closed) which shall change state when the assembly is tripped.
 5. The starter sub-assembly shall be equipped with field replaceable contacts.
 6. The starter assembly shall have a minimum of one (1) normally open and one (1) normally closed auxiliary contact set.
 7. The starter assembly shall be equipped with field replaceable mechanical lugs for main power wiring connections.
 8. In order to minimize the number of ACL starter spares which the end-user must maintain in inventory, the minimum starter size shall be NEMA Size 2.
- B. ACL type motor starter shall not be used for pumps sized greater than 19 HP.
1. Provide products of Square D, no substitutions permitted.

2.02 REDUCED VOLTAGE SOLID STATE STARTER (RVSS) MOTOR STARTER ASSEMBLIES

- A. The starter shall be designed and installed to operate with a non-reversing shorting contactor configuration which shall automatically transfer the pump motor main load from the electronic controller to the contactor following the ramp-up time period of starting the motor.

The electronic controller shall continue to monitor data such as pump load amps and shall control such functions as shut-down of the pump motor in response to over-current, single-phasing, and other conditions which may cause damage to the pump motor/control system.

- B. The controller shall be equipped with terminal connection points (terminal strip) which shall accept stranded copper THHN wire for the commands listed below, control, and annunciation signals as a minimum:
1. Pump "run" command
 2. Pump "stop" command
 3. Activate the shorting contactor sub-assembly. (Full-Speed Contact)

4. Pump motor failure (overload, phase failure, and etc.) condition to activate external fault devices
 5. Pump is running condition external annunciation
 6. Pump running amps proportional to a 4-20ma signal output, (shielded pair)
 7. Digital I/O logic data signals
 8. Remotely mounted graphic display device
- C. The controller shall be equipped with mechanical wire lugs to accept the pump motor input power conductors which shall be readily accessible to field maintenance personnel.
- D. The controller shall be equipped with a graphic display and input programming device for observation of status and programming of the controller by field personnel. This shall be mounted in the control panel inner door.
- E. This type motor starter assembly shall be used for pumps sized 20 HP and larger.
- F. Provide Square D Altistart 48 series, no substitutions permitted.

2.03 VARIABLE FREQUENCY DRIVE CONTROLLER ASSEMBLIES (VFD)

- A. Variable Speed Drive (VFD) systems shall be employed at lift stations where:
1. The wet well effluent wastewater exiting the station into the force main system is operationally required to be kept at a relatively constant rate-of-flow regardless of the influent rate-of-flow under "normal" conditions.
 2. The wastewater pumping station primary power from the utility is not three-phase, four-wire configured, (the standard pumps utilized by the Wastewater Conveyance Department shall ordinarily require three-phase power for proper operation).
- B. VFD equipment assemblies shall have the below listed features/capabilities as a minimum:
1. Harmonic reduction (filtering) of both the input and output power of the VFD designed to mitigate the introduction of electrical "noise" into associated control and monitoring circuitry.
 2. The capability to generate a third phase for the pumping assembly at the appropriate voltage and load current levels for the normal operation of three-phase pump assemblies.
 3. A graphic display device which shall provide for observation of status and programming of the controller by field personnel.
 4. The controller shall be equipped with terminal connection points (terminal strip) to accept stranded copper THHN wire conductors for routing the below listed command, control, and annunciation signals as a minimum:
 - a. Pump "run" command
 - b. Pump "stop" command

- c. Pump motor failure (overload, phase failure, and etc.) condition activating external controls
 - d. Pump is running condition annunciation
 - e. Digital I/O logic data signals
 - f. Pump running (AMPS 4-20mA) signal
 - g. Analog (4-20mA) speed control signal input, where applicable
 - h. Selectable manual speed control
 - i. Remotely mounted graphic display device
5. The controller shall be equipped with wire lugs for power in and out that are readily accessible to field maintenance personnel.
 6. Provide Square D Altivar 61 series, no substitutions permitted.

PART 3 – TESTING, INSPECTION, AND FINAL ACCEPTANCE

3.01 EQUIPMENT START-UP/PROGRAMMING

- A. The Contractor shall coordinate and retain the technical services of factory certified personnel to ensure that all assemblies/sub-assemblies are correctly installed, programmed per the owner's requirements, and acceptable for commissioning and warranty purposes.
- B. The equipment systems and sub-systems operational capabilities shall be demonstrated at the operational site to the satisfaction of the Inspector or his/her representative as well as the Wastewater Conveyance Maintenance Superintendent or his/her representative.

3.02 DOCUMENTATION AND END-USER O&M PERSONNEL TRAINING

- A. A minimum of one (1) copy of operating and maintenance instructions shall be provided to the Wastewater Conveyance Department Maintenance Superintendent or his/her representative in printed form as an integral part of the final acceptance inspection and acceptance. Also provide electronic PDF file on digital CD.
- B. A minimum of one (1) copy of blueprints, Red Line (hand) drawings with field notes, installation and programming mark-up notes and interconnection wiring diagrams utilized in this installation shall be provided to the Wastewater Conveyance Maintenance Superintendent or his/her representative as an integral part of the final inspection and acceptance. Also provide PDF of information on CD.
- C. A printed copy of all settings for the variable frequency drive or reduced voltage solid state starter shall be provided to the Wastewater Conveyance Maintenance Superintendent or his/her representative as an integral part of the final inspection and acceptance. Also provide PDF of information on CD.

- D. The Contractor shall coordinate with all applicable vendors and the City of Savannah Wastewater Conveyance Department Maintenance Superintendent to schedule and provide on-site operating and maintenance training for city personnel.

PART 4 – WARRANTY

Warranty provisions shall be as described in Specification 11100.

END OF SECTION 16482

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SECTION 16620

SANITARY SEWER PUMP STATION EMERGENCY STAND-BY POWER SYSTEM

PART 1 – GENERAL

1.01 GENERAL

Emergency stand-by power systems shall be provided by the Contractor and installed, tested, commissioned and warranted as required in the Contract Documents as supplemented by this STANDARD SPECIFICATION.

1.02 CODES AND PERMITS

All electrically related work, installations, equipment, and devices shall conform to the requirements of the following listed standards as a minimum. The electrical design engineer shall be permitted to increase/enhance the requirements but SHALL NOT be permitted to decrease/reduce these requirements.

- A. NFPA 70 National Electrical Code
- B. NFPA 110 Standard for Emergency and Standby Power Systems
- C. NEMA Standards Publication 250-2008
- D. Local utility company standards and installation guidelines with respect to service entrance and metering
- E. USEPA Non-Road Sources Emissions Standards 40 CFR 89
- F. All municipal and state regulations regarding electrical installations and “on-site” power generation equipment.

1.03 SCOPE OF WORK

Provide, install, test, warrant, commission, and conduct acceptance testing for a completely operational Emergency Standby Power System as described in NFPA 110, NFPA 70 and other related standards to include all devices, assemblies, external wiring and accessory items as specified herein. All equipment shall be new, factory prototype test supported, and placed in service.

1.04 SUBMITTALS

Submittals shall be provided as specified in the Contract Documents.

PART 2 – PRODUCT DESCRIPTION

- A. The contractor shall provide a diesel fueled emergency stand-by power system. This shall include the generator, controls, enclosure, sub-base fuel tank and automatic transfer switch. The contractor shall provide a complete system, products of a single manufacturer, or separate items covered under the generator manufacturer's warranty.
- B. Acceptable manufacturers:
 - 1. Generators
 - a. Cummins
 - b. Caterpillar
 - c. Generac
 - 2. Automatic Transfer Switch
 - a. Cummins
 - b. ASCO
 - c. Generac

2.01 EQUIPMENT

- A. General - The equipment/material/services shall consist of:
 - 1. A diesel engine driven electrical power generating set
 - 2. An equipment protective enclosure
 - 3. An automatic power transfer switching assembly
 - 4. A skid-base or sub base style fuel storage tank assembly with necessary accessories
 - 5. Ancillary equipment assemblies/components as described herein
 - 6. Technical services/labor for final acceptance testing and commissioning
- B. Equipment Description(s):
 - 1. Diesel-Engine Powered Generator Set
 - a. The prime mover shall be 4-cycle diesel powered with on-board battery charging alternator, spin-on fuel, lube, and (as required) coolant filter(s), dry-element air cleaner, and an integral set-mounted radiator cooling system.
 - b. The engine shall be certified to U.S. EPA Non-Road Source Emissions Standards 40 CFR 89 requirements.
 - c. The main alternator shall be a brushless, 4-Pole, revolving field type with the rotor close-coupled to the prime mover by way of a flexible disc design.

- d. Alternator cooling shall be provided by a direct-drive centrifugal blower-fan design.
- e. Excitation shall be:
 - i) PMG (permanent magnet) design for all units sized 30 KW or greater.
 - ii) Units sized smaller than 30 KW shall have PMG excitation or an excitation system designed and constructed such that an integral excitation boost function working with a torque-matching type automatic voltage regulator (AVR) provides supplementary excitation power in response to the application of large load(s) resulting in the minimization of generator output voltage dip and recovery time. Voltage and frequency dip shall not exceed 15% and shall have a recovery time of no more than 8 seconds.
- f. The main alternator shall be a broad range, 12-lead, field re-connectable for 120/208V, 120/240V, and 277/480V, three-phase, four wire output unit with an integrated load circuit breaker.
- g. The generator shall meet or exceed all Emergency Standby Power ISO Standards.
- h. The generator set-mounted control system shall have the features listed below.
 - i) Integrated isochronous governing and fuel control in accordance with ISO 3046, AS 2789, DIN 6271, and BS 5514 standards.
 - ii) An integrated 3-Phase sensing voltage regulation system with automatic single and three- phase fault regulation.
 - iii) Integrated AC protective functions to include over/under voltage, short-circuit, over-current, and overload protective warning and shut-down features.
 - iv) An integrated engine management system to include configurable cycle-cranking functions and configurable start sequencing.
 - v) A comprehensive warning and shut-down protection system to include configurable warning and shut-down conditions.
 - vi) Data display(s) to include 3-Phase AC voltage output, load current, engine oil pressure, coolant temperature, DC voltage/current, non-resettable engine elapsed (run) hours, fault status, and a fault reset function.
 - vii) The control panel shall be of NEMA 3R or better construction.
- i. The main alternator shall be constructed such that it meets the requirements of NEMA Class H insulation with temperature rise of 125 °C or better.
- j. The generator set housing shall include the following features at a minimum:
 - i) Directly attachable to either the generator skid base or fuel tank.
 - ii) Stainless steel assembly hardware.

- iii) Rain collar and rain cap/exhaust constructed such that rainwater, sleet, snow, sand etc. is precluded from entry to the exhaust system whether the engine is running or not.
- iv) Easily accessed lifting points suitable for spreader bars and/or a forklift.
- v) Compatibility with sub-base fuel tanks.
- vi) Designed for use out-of-doors in ambient temperatures ranging up to 50 degrees Celsius.
- vii) Constructed such that the electrical stub-up area(s) mates with that of its associated generator set.
- viii) Designed with a minimum wind rating of 150 mph.
- ix) A sufficient number of recessed doors on all sides for ready access to all service points.
- x) Access doors equipped with the means to securely lock them with standard commercial padlocks.
- xi) The enclosure shall be coated with factory applied weather and corrosion resistant paint.
- xii) The enclosure shall be constructed such that, with the unit running under 100% of its rated load, sound pressure at seven meters (approximately 23 feet) does not exceed:

_____ No special sound attenuation is required

_____ db

_____ As determined by an attached sound survey

2. Generator Set Fuel Storage Tank:

- a. The fuel storage tank shall be an sub-base style with sufficient capacity for the generator set to run at 100% of its rated load for 36 continuous hours. The fuel tank capacity shall not exceed 1200 gallons. If the fuel volume required to comply with the specified run-time exceeds 1200 gallons the contractor shall notify and coordinate with the City of Savannah for a fuel spillage containment plan.
- b. The tank shall be of double-walled design compliant with UL 142 and NFPA 37.
- c. The tank shall be equipped with UL listed venting devices, a rupture basin leak detection device, a tank level indicator (fuel gauge) device, and a lockable (padlock) type fuel fill cap.
- d. The tank shall have all necessary threaded penetrations and pick-up tube(s) for supply and return fuel lines to/from the engine (size as recommended by the

engine manufacturer), venting, filling, and etc. devices. Flexible fuel lines, applicable fittings and necessary loss-of- prime prevention devices shall be supplied by the vendor.

- e. The tank shall be constructed such that a minimum of four (4) inches of clearance exists between all points of the tank bottom and the surface to which it is mounted in order to provide air circulation to reduce/eliminate corrosion-causing moisture accumulation.
 - f. The tank shall be constructed such that its overall height does not exceed 36 inches.
 - g. The tank shall have accommodations for anchoring to a concrete pad.
 - h. The tank shall be constructed such that a generator set with housing may be securely fastened on top of it with stainless steel hardware.
 - i. The electrical conduit stub-up area shall mate with the generator and housing mounted to it and shall be readily accessible by service/installation personnel by way of removing an access plate from the tank after the entire structure (generator, housing, and tank) is assembled.
 - j. The generator set and housing shall be securely mounted on top of the fuel tank with Grade 8 stainless steel hardware. This hardware shall be supplied by the vendor.
 - k. All external surfaces including the bottom of the fuel tank shall have a minimum of two (2) coats of a polyurea factory applied coating.
3. Automatic Transfer Switch:
- a. The Automatic Transfer Switch (ATS) shall be a 4-Pole, Double-Throw device with a switched neutral, mechanical lug wire termination devices integrated. The ATS shall be capable of both manual and automatic operation. Four-Pole automatic transfer switches shall be provided with programmed transition and intermediate position configuration.
 - b. The ATS shall be rated for continuous operation of the main utility service as required by NFPA 70 Article 700, (voltage and current rating shall equal or exceed the main utility service to the station).
 - c. The ATS shall be equipped with a NEMA TYPE 4 enclosure. Stainless steel NEMA Type 4X and NEMA 1 enclosures are not acceptable.
 - d. The ATS shall be 100% compliant with UL 1008.
 - e. The ATS shall be 100% compliant with NFPA 70 and 110.
 - f. The ATS shall be 100% compliant with NEMA ICS 10 and IEEE 446.
 - g. The ATS shall be equipped with arc chutes to cool and quench arcing with barriers to prevent inter-phase flashover.

- h. The ATS shall be the power contactor type. Circuit breaker or molded case switch type are not acceptable.
- i. The ATS shall be rated to carry 100% of its rated current at rated voltage.
- j. The ATS shall be equipped with a minimum of two sets of dry form-C contacts (one set for each power source) for remote indication of which power source (Normal or Emergency) is connected to the load. These contacts shall be rated for a minimum of 10 AMPS at 250VAC and shall be readily accessible at terminal strips for easy field wiring.
- k. The ATS shall be equipped with a manual operating capability suitable for safe end-user operation.
- l. The ATS operating mechanism shall be of open transition (break-before-make) design with mechanical and electrical interlocking feature(s) which preclude connecting the load to more than one power source at a time.
- m. The ATS transfer mechanism shall be designed and constructed such that three (3) distinct positioning conditions exist with respect to the load connection. These conditions shall be:
 - i) Load connected to NORMAL (utility) power source.
 - ii) Load connected to EMERGENCY (generator) power source.
 - iii) Load not connected to any power source, (intermediate).
- n. The ATS transfer mechanism shall be designed and constructed such that the end-user may place it in any one of its three (3) position conditions with the control set for manual operation and it will remain in that position unattended until is manually placed in another position, or the control is set for automatic operation.
- o. The ATS main contacts shall be manufactured of high pressure silver alloy material to resist burning and pitting in order to extend their anticipated service life.
- p. The ATS shall, at a minimum, be equipped with the user-adjustable time delay features listed below:
 - q. Time Delay – Engine Start
 - r. Time Delay – Normal to Emergency Transfer
 - s. Time Delay – Load Disconnected from all Power
 - t. Time Delay – Emergency to Normal (Re-Transfer)
 - u. Time Delay – Engine Cool down Period
- v. The ATS control shall be equipped with a user-programmable exerciser function which allows for the programming of exercise start and stop times, length of exercise period, day of the exercise, single weekly or multiple exercise events,

and a manual exercise initiate/terminate function which does not require special tooling and/or software.

- w. The ATS integrated control shall also have the features/functions listed below as a minimum:
- i) Voltage sensing of all normal (utility) power source phases with user-adjustable pick-up and drop-out points.
 - ii) Voltage sensing of at least one phase of the emergency (generator) power source with user-adjustable pick-up and drop-out points.
 - iii) Control push button(s) and/or switch(s) to initiate a system test and/or override selected time delays.
 - iv) End-User-programmable exercise and test functions for exercising/testing under “with load” and “without load” conditions.
 - v) Front panel indicator display(s) showing power source availability and which source the load is connected to. This display shall be constructed such that constant exposure to sunlight and/or weather conditions do not degrade its readability.

4. Ancillary Equipment:

- a. The engine-driven generator shall be equipped with a tank style coolant/block heater sized according to the engine manufacturer’s recommendation to assist with rapid engine starting and stabilization.
- b. The engine coolant/block heater assembly shall be equipped with a six (6) foot long AC power cord configured with a NEMA 5-20P male plug for 120VAC or 6-20P male plug for 240VAC as applicable for easy power removal during service and/or repair events.
- c. The coolant/block heater assembly shall be installed in/on the generator system such that it can be readily isolated from the engine coolant sub-system by closing “ball-cock” type valves so that field service personnel may easily replace the heater and associated hoses without draining the coolant sub-system or taking the generator out of service.
- d. The generator system shall be equipped with a battery charger-maintainer SENS Model NRG22-10-RC mounted inside the generator enclosure such that it is readily accessible for service activities and/or operator viewing of read-outs. The charger shall be equipped with a six (6) foot long AC power cord configured with a NEMA 5-20P male plug. No substitutions permitted.
- e. The engine-generator shall be equipped with the manufacturer recommended lead-acid starting battery(s) and associated cables. Provide battery straps and heater per NFPA 110.

- f. The engine-generator shall be equipped with the manufacturer recommended. EPA compliant exhaust system.

2.02 TESTING AND COMMISSIONING

On-site start-up, testing, and system commissioning shall be accomplished by a manufacturer's certified representative. City of Savannah personnel shall be present as witness to these procedures and to assist with equipment operation for all testing, commissioning, and acceptance activity. The below listed activities and demonstrations shall be required as a minimum:

- A. Install starting battery(s) and associated cabling. Connect/adjust the battery charger-maintainer as necessary.
- B. Install flexible fuel lines, fittings, and loss-of-prime prevention devices. Inspect any feeder fuel piping and verify that it is correctly installed, (notify City of Savannah of incorrect installation). Prime the generator set fuel system.
- C. Inspect and verify that all electrical load and control wiring to/from the generator and ATS are properly sized, installed, and terminated.
- D. Inspect and verify that all of the various sub-assemblies (housing, fuel tank, etc.) are correctly assembled.
- E. Start and run the generator unit under no-load conditions and verify the correct voltage, frequency, and phase rotation is present at the generator load breaker output terminals. Allow the unit to run for a sufficient time to achieve normal operating temperature and verify the correct operation of the engine thermostat.
- F. Verify that the phase rotation and High Leg (240VAC units) at the emergency terminals of the ATS match the normal (utility) terminals as applicable. Correct as necessary.
- G. Verify the correct operation of the ATS in response to both power-fail and system-test conditions with no load applied.
- H. Verify correct system operation under simulated power failure and restoration conditions with the site load applied:
 - 1. The system shall automatically respond to a power failure condition by starting the generator and correctly transferring the load to the emergency power source. Verify that all applicable time delay functions operate correctly.

2. The system shall automatically respond to normal power restoration by re-transferring the load to the normal power source and returning to a standby condition. Verify that all applicable time delay functions operate correctly.
3. With the site load(s) operating on emergency power, start and run all load devices and verify that there is no relay drop-out or degradation of function of any sub-system at the site while operating on emergency power due to motor starting in-rush effects or other anomalies of the station load(s). Programmed start of the station loads shall be permissible under the conditions listed below:
 - a. All single-phase loads and at least one main load device shall be supplied power at step A.
 - b. The remaining station loads may be applied one at a time providing that there is no more than 10 seconds delay between each application until 100% of the station load is applied.
4. Verify the correct operation of ALL engine safety and alternator protection shut-down and warning functions by simulating the applicable fault.
5. Adjust all time delay functions to end user requirements and set the exerciser function and time period to end user requirements.
6. Load test the system at 100% of rated load for two consecutive hours in compliance with NFPA 110 Level I using a resistive load bank.
7. Demonstrate a successful single-step pick-up of a 100% rated load.

2.03 ADDITIONAL REQUIREMENTS

- A. The generator shall be sized such that when 100% of the site KW load is applied, the generator shall not be loaded less than 35% of its nameplate capacity nor more than 87% of its nameplate rating capacity.
- B. The ATS unit shall be rated to equal or exceed the main utility service to the station.
- C. All Emergency Power System assemblies shall be warranted for five (5) years or 1,500 hours of operation whichever comes first with a comprehensive factory warranty that includes all parts, labor, and travel.
- D. Provide a minimum of one complete set of operator instruction and maintenance manuals to the end user department representative in printed form.
- E. Provide familiarization and operator training to the end user department personnel as requested. Provide 4 hours of training.

2.04 FINAL ACCEPTANCE

Final acceptance of the Emergency Standby Power System shall be upon of all the requirements of this specification and Specification 11100 being certified acceptable by the City of Savannah Inspector and the Wastewater Conveyance Maintenance Department office of the City of Savannah.

END OF SECTION 16620