SECTION 02960

RECLAIMED WATER AND REJECT POND LINERS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install the liners in the North Reclaimed Water Storage Pond and the Reject Storage Pond as shown on the Drawings.

B. Related Work Specified Elsewhere:

1. Section 02200 - Earthwork
2. Section 03300 – Cast-in-Place Concrete

1.02 QUALITY ASSURANCE

A. The membrane liner shall be furnished by a manufacturer who is fully experienced, reputable and has at least 30,000,000 square feet of previous experience in the manufacture of liner material for similar applications for a time period of at least 5 years.

B. Installers Qualifications

1. The Geomembrane Installer shall be the Manufacturer, an approved Manufacturer's Installer, or a Contractor approved by the Owner's Representative.
2. The Geomembrane Installer shall have at least three years' experience in the installation of the specified or similar geoemembrane. The Geomembrane Installer shall have installed at least 10 projects involving a total of 5,000,000 FT^2 of the specified type of geomembrane or similar liner during the last three years.
3. Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 5,000,000 FT^2 of geomembrane of the type specified or similar product.

4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 3,000,000 FT^2 of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.
5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.
6. All technicians who shall be involved in the field installation shall have at least 1,000,000 square feet of field seaming experience.
7. The Contractor shall submit the resumes of the field engineer and technicians stating the name, position and experience including the list and size of previous projects involved.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Agru America, Inc., HDPE Smooth Liner Geomembrane
2. or approved equal.

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01340 – Shop Drawings, Project Data and Samples to the Owner’s Representative.

1. Documentation of manufacturer’s qualifications.
2. Manufacturer’s Quality Control program manual or descriptive documentation.
3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.
4. Sample of the material.
5. Documentation of Installer’s qualifications

    a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.

b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
c. Quality Control Program.

6. Example Material Warranty and Liner Installation Warranty.

B. Shop Drawings

1. Submit copies of shop drawings showing the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner's Representative. Butt seams on a slope, if allowed, should be staggered.
2. Any variance or details which deviate from the construction drawings.
3. Liner fabrication and installation schedule.

C. Additional Submittals (In-Progress and at Completion)

1. Manufacturer's warranty.
2. Geomembrane installation warranty.
3. Daily written acceptance of subgrade surface.
4. Low-temperature seaming procedures, if applicable.
5. Prequalification test seam samples.
6. Field seam non-destructive test results.
7. Field seam destructive test results.
8. Daily field installation reports.
9. Installation record drawings.

D. In the event that it is impossible to conform with certain details of these Specifications due to different manufacturing techniques, submit a written description with all nonconforming aspects clearly indicated.

1.04 PRODUCT HANDLING

A. The rolls or panels of liner shall be packaged in a polyethylene film and shipped by appropriate means so that no damage is caused. Transportation shall be the responsibility of the Manufacturer.

B. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

C. Materials shall be shipped in a closed trailer or on a flat bed trailer and delivered to the site only after the required submittals have been received and approved by the Owner's Representative. Off-loading and storage of the liner is the responsibility of the Contractor. The Contractor shall be responsible for replacing any damaged or unacceptable material at no cost to the Owner. No off-loading shall be done unless the Inspector is present. Damage during off-loading shall be documented by the Inspector or Contractor. The Owner's Representative shall be the final authority on determination of damage.

D. The liner shall be stored so as to be protected from puncture, dirt, grease, water, moisture, mud mechanical abrasions, excessive heat, or other damage. The liners shall be stored on even stone free areas, using a layer of geotextile between the ground and the liners. Maximum stack height shall not exceed 5 rolls.

E. The Contractor will be allocated sufficient space by the Owner to store the liner upon its arrival. On-site handling of the liner is the responsibility of the Contractor. Appropriate handling equipment shall be used when loading or moving rolled liner from one place to another. Appropriate equipment includes spreader and roll bars for deployment, cloth chokers and spreader bar for off-loading. Procedures for handling the liner shall be approved by the Inspector.

F. The method used to unroll the panels shall not cause scratches or crimps in the liner and shall not damage the supporting soil.

G. The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels). Wrinkles shall be identified as to proper location and compensation shall be identified on the Contractor's and Inspector's drawings. Ballast shall be used to prevent relocation of the compensating wrinkles by wind.

H. Adequate loading (i.e., sand bags, tires, or similar items that will not damage the liner) shall be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

I. Direct contact with the liner shall be minimized.

J. If the above conditions are not fulfilled, the Inspector will identify the involved areas and immediately inform the Owner's Representative.

K. Liner damaged during transit, off-loading, handling, etc., shall be so identified and set aside. During the unrolling of the liner, the Contractor shall visually inspect the sheet surface in the presence of the Inspector. Faulty or suspect areas shall be marked for testing and/or repair, as determined by the Inspector. Liner stock that is faulty (requires more than one patch per 5,000 square feet), shall be replaced by the Contractor at the Contractor's expense.

1.05 WARRANTY

A. A written warranty shall be obtained from the Manufacturer as part of the contract documents. This document shall warrant the quality of the material. The Manufacturer shall certify in writing that the installed liner product meets the requirements of these specifications and the project plans; and under normal weathering the sheet material is warranted for a period of 20 years; and that the sheet will not fail due to environmental stress cracking or flex fatigue within 20 years of installation.

B. A written warranty shall be obtained from the Geomembrane Installer as part of the Contract Documents. This document shall warrant the workmanship of installation and seaming of the geomembrane. The Geomembrane Installer shall certify in writing that the installation and seaming of the geomembrane meets the requirements of these specifications, and that the sheet will not fail due to seam failure within 20 years of installation.

1.06 GEOMEMBRAME INSTALLATION PRE-CONSTRUCTION MEETING

A. A Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative, Engineer, and the Earthwork Contractor.

B. Topics for this meeting shall include:
1. Health and Safety

2. Lines of authority and communication. Resolution of any project document ambiguity.
3. Methods for documenting, reporting and distributing documents and reports.
4. Procedures for packaging and storing archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane.
7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation.
9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
10. Deployment techniques including allowable subgrade for the geomembrane.
11. Plan for controlling expansion/contraction and wrinkling of the geomembrane.
12. Measurement and payment schedules.
13. Responsibilities of each party.

C. The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to all parties.

1.07 REFERENCES

A. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

B. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

C. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

D. D 3895, Test method for Oxidative Induction Time of Polyolefins by Thermal Analysis.

E. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

F. D 4833, Test Method for Index puncture Resistance of Geotextiles, Geomembranes and Related Products.

G. D 5199, Standard Test method for Measuring Nominal Thickness of Smooth Geomembranes.

H. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.

I. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.

J. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.

K. D 5820, Test method for Air Testing.

L. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.

M. D 5994, Standard Test Method for Measuring Nominal thickness of Textured Geomembranes.

N. GRI GM 13, Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

PART 2 - PRODUCTS

2.01 MATERIAL SPECIFICATIONS

A. Liner Material:

1. The membrane liner shall consist of 60 mil HDPE smooth geomembrane material with a density of 0.94 gram per cubic centimeter or greater manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures and exhibiting very high soil/liner interface surface friction properties. The HDPE liner shall be manufactured to meet or exceed all the GRI GM 13 test values, frequency of testing and functional requirements.
2. The Contractor shall, at the time of bidding, submit a certification from the manufacturer of the sheeting, stating that the sheeting meets the physical properties specified.

3. The liner material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter verified by 100% in-line spark testing or equivalent. Any such defect shall be repaired using the extrusion welding technique in accordance with the manufacturer's recommendations.
4. The lining material shall be manufactured in a minimum width of 22.0 ft. Labels on the roll shall identify the thickness, length, width, and manufacturer's mark number.
5. The liner material shall meet the following minimum physical characteristics:

Property	**Test Method**	**Units**	**Value**
Thickness (Nominal)		Mils	60
Thickness (Min Ave)	ASTM D5199	Mils	60
Thickness (Lowest indiv For 8 of 10 spec)	ASTM D5199	Mils	54
Thickness (Lowest indiv For 1 of 10 spec)	ASTM D5199	Mils	51
Density	ASTM D792, Method B	g/cc	0.94
Tensile Properties (Ave, Both Directions)	ASTM D6693, Type IV		
Strength at Yield (Min Ave)		Lbs/in width	132
Elongation at Yield (Min Ave)		Percent	13
Strength at Break (Min Ave)		Lbs/in width	240
Elongation at Break (Min Ave)		Percent	700
Tear Resistance (Min Ave)	ASTM D1004	Pounds	45
Puncture Resistance (Min Ave)	ASTM D4833	Pounds	120
Carbon Black Content (Range)	ASTM D4218	Percent	2-3
Stress Crack Resistance (Single Point)	ASTM D5397 (Appendix)	Hours	300
Oxidative Induction Time	ASTM D3895 - 200°C, 1 atm oxygen	Minutes	≥100
Melt Flow Index	ASTM D1238, 190°/cm 2.16 Kg	Grams/10 Minutes	≤1.0
Oven Aging with HPOIT	ASTM D5721	Percent	80
(Percent Retained	ASTM D5885,		

after 90 Days)	150°C, 500 psi oxygen		
UV Resistance with HPOIT, (Percent Retained after 1,600 hours)	GRIGM11; ASTM D5885, 150°C, 500 psi oxygen	Percent	50

6. The fabricated seams (if applicable) and field seams shall meet the following specifications:

Seam Strength	ASTM D3083	Minimum 90% of sheet Strength
Peal Strength	ASTM D413 or ASTM D638	Film Tear Bond and Minimum of 50% of Sheet Strength

2.02 FACTORY QUALITY CONTROL

A. Raw Material

1. The manufacturer shall test the resin to ensure the consistency of the raw material quality. The manufacturer/installer shall test for the following properties:

a) Density	(ASTM D792)	1/resin batch
b) Melt Index	(ASTM D1238)	1/resin batch
c) Low Temp Brittleness	(ASTM D748)	1/resin batch

2. The results of this testing shall be evaluated and, if the physical specifications are not satisfied, the resin batch in question shall not be accepted for extruding the liner. As a result of this testing, the manufacturer shall be prepared to certify as to the quality of the raw material as defined by the physical specifications.

B. Fabrication:

1. The carbon black for ultraviolet protection shall be added to the otherwise pure HDPE resin as part of the sheet extrusion process. The manufacturer shall perform testing to maintain the specific carbon black content and to determine if adequate dispersion is being achieved.
2. Automatic monitoring of controlling parameters shall be an integral part of the extrusion process. Surface appearance and sheet thickness shall be monitored continuously during the

extrusion process. The sheet thickness shall be continuously monitored by electronic methods and/or periodically inspected manually. An acceptable sheet thickness shall be within 10% of the specified thickness. Sheets within less than 10% of the specific thickness shall be acceptable; those in excess of or thinner than within 10% of the specified thickness shall be rejected.

3. Finished goods shall be periodically tested to evaluate their stress-deformation characteristics.
4. The following test program shall be conducted at least twice per shift:

    a) Tensile and Elongation properties
    b) Thickness of Material
    c) Carbon Black content
    d) Puncture Resistance

5. The above test shall be conducted in accordance with ASTM methods as listed in Paragraph 2.01 - MATERIAL SPECIFICATIONS, to ensure that the finished products meet the minimum Specifications. Finished products shall be sampled at least twice per shift. Samples shall be taken even if they cannot be tested until a later date. Sampling shall be done by production personnel.
6. All factory control tests shall be properly recorded and shall be made available to the Owner's Representative for his review.
7. The manufacturer's geomembrane quality control certifications shall be supplied to the Owner's Representative to verify that the materials supplied for the project are in compliance with all product and or project specifications in this Section. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production manager, or Technical Services manager. Certifications shall include lot and roll numbers and corresponding shipping information.
8. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project are made from the same material type and are compatible.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Surfaces and anchor trench shall be prepared by the Contractor in accordance with plans and specifications. Surfaces and anchor trench to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects or debris of any kind. The surface shall provide

a firm, unyielding foundation for the liner with no sudden sharp or abrupt changes or breaks.

B. Each day the Geomembrane Installer shall certify in writing that the surface on which the liner will be installed is acceptable. After the supporting soil has been accepted by the Geomembrane Installer, it shall be the Geomembrane Installer's responsibility to indicate to the Owner's Representative any change in the supporting soil condition caused by natural conditions or occurrences that may require repair work. The general contractor shall provide for dewatering and for drying of the subgrade as required during construction. Special care shall be taken to maintain the prepared soil surface. Any damage to the subgrade caused by this installation shall be repaired at the Geomembrane Installer's expense in accordance with the requirements of the applicable Earthwork specifications.

3.02 INSTALLATION

A. Installation of the liner shall be performed by the Geomembrane Installer. The Geomembrane Installer shall be responsible for inspection of the panel rolls at the jobsite. Should rolls show damage from transit, they will be so identified by the Geomembrane Installer and set aside. During the unrolling of the panel rolls, the Geomembrane Installer shall visually inspect the sheet surface. Any faulty areas shall be marked and repaired in an approved manner by the Geomembrane Installer.

B. Liner Placement and Layout:

1. The panels shall be laid out according to approved engineering plans and shall not deviate from the approved plans except with the prior approval of the Owner and the Owner's Representative. Panels shall be overlapped sufficiently to permit thermal fusion welding without having to splice small sections of materials into the general plan layout.
2. The number of panels to be deployed in any day shall be limited to the number of panels to be seamed in the same day.
3. No equipment used shall damage the liner by handling, trafficking, leakage of hydrocarbons, or other means.
4. No personnel working on the liner shall smoke, wear damaging shoes, or engage in other activities that could damage the liner.

5. Liner clamps or other metal tools shall have rounded corners, and shall never be tossed or thrown.
6. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably – expected wind conditions. Sand bag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geomembrane.
7. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations shall be defined in the preconstruction meeting.
8. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.
9. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. The geomembrane shall rest in intimate contact with the subgrade.
10. Wrinkles caused by panel placement or thermal expansion should be minimized.
11. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and if approved by the Owner's Representative.
12. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 inches).

C. Field Seaming:

1. All areas to be seamed shall be cleaned of dust and dirt and completely dry prior to seaming.
2. All sheeting shall be welded together by means of the thermal fusion welding process using automatic fusion welding equipment. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.
3. All seams on side slopes shall run vertically to the center line of the pond. Seams parallel with the center line of the pond on the side slope shall not be allowed.

4. No “fish mouths” shall be allowed within the seam area. Where “fish mouths” occur, the material shall be cut, overlapped, and an overlap thermal fusion weld shall be applied. All welds on completion of the work shall be tightly bonded. Any membrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of membrane.
5. Unless authorized in writing by the Owner’s Representative, welding shall be performed between 20°F and 104°F as measured 6-inches above the liner surface. No welding shall be performed in the presence of free moisture.
6. Between 20°F and 40°F, seaming shall be allowed if the liner is preheated by a hot air device and if there is not excessive cooling resulting from wind.
7. Above 40°F, no preheating will be required unless deemed necessary by the Inspector.

3.03 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

A. Provide penetration sealing systems as shown on the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The prefabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. Attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365. Spark testing shall be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.
2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non-welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 inch) above the weld moving

slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.

3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.
4. Care shall be taken if flammable gases are present in the area to be tested.

3.04 FIELD QUALITY CONTROL

A. The Owner's Representative shall be notified prior to all prequalification and production welding and testing.

B. Prequalification Test Seams

1. Test seams shall be prepared and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.
2. Test seams shall be made by each welding technician and tested in accordance with ASMT D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, test seams shall be made by each technician 1 time every 4-6 hours. Additional tests may be required with changes in environmental conditions.
3. Two 25 mm (1 inch) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen should fail in the parent material and not in the weld, "Film Tear Bond" (F.T.D. failure). Seam separation equal to or greater than 25% of the track width shall be considered a failing test.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed below. Four specimens shall pass for the test seam to be a passing seam.

Thickness, mils	60

Hot Wedge Seams	
Shear Strength Lb./in.	120
Shear Elongation at Break, Percent	50
Peel Strength Lb./in.	91
Peel Separation, Percent	25
Extrusion Fillet Seams	
Shear Strength Lb./In.	120
Shear Elongation at Break, Percent	50
Peel Strength Lb./In.	78
Peel Separation, Percent	25

5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.
6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner's Representative for archiving.

C. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner's Representative.
2. Testing shall be done as the seaming work progresses, not at the completion of all field seaming, unless agreed to in advance by the Owner's Representative. All defects found during testing shall be numbered and marked immediately after detection. All defects found shall be repaired, retested and remarked to indicate acceptable completion of the repair.
3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.
4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate all test methods to the Owner's Representative to verify that the test procedures are valid.

5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:

   a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.
   b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 5 psig.
   c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 12 inches by 48 inches (width and length of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, and maintain an initial vacuum of approximately 5 psig for approximately 5 seconds. The geomembrane shall be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over to the next adjoining area with an appropriate overlap and the process repeated.
   d. All areas where soap bubbles appear shall be marked, repaired and then retested.
   e. At locations where seams cannot be non-destructively tested, such as pipe penetrations, alternate nondestructive spark testing or equivalent shall be substituted.
   f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:

a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 30 psig mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.

b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 30 psig, and the valve closed. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 4 psig after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying the pressure drop on the needle to ensure testing of the entire seam. The needle or other approved pressure feed devices shall be removed and the feed hole sealed.

c. If loss of pressure exceeds 4 psig during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.

d. Destructive Field Seam Testing

1) One destructive test sample per 500 linear foot seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner’s Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner’s Representative as seaming progresses.

2) All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The geomembrane Installer shall repair all

holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3) The destructive sample size shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner's Representative as an archive sample; one section given to the Owner's Representative for laboratory testing; and one section retained by the Geomembrane Installer for field testing.

4) For field testing, the Geomembrane Installer shall cut 10 identical one inch wide replicate specimens from his sample. The geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel test will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria with less than 25% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory, if required.

5) Independent seam testing shall be conducted in accordance with ASTM 5820 or ASTM D4437 or GRI GM 6.

6) Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative.

7) For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the Geomembrane Installer at locations indicated by the Owner's Representative. Typically, 10 feet on either side of the failed sample and laboratory seam tests shall be performed. Passing tests shall be an

indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 150 feet in length shall be destructively tested.

e. Identification of Defects

1) Panels and seams shall be inspected by the Geomembrane Installer and Owner's Representative during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

f. Evaluation of Defects: Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1) If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.
2) Defective seams, tears or holes shall be repaired by reseaming or applying an extrusion welded cap strip.
3) Reseaming may consist of either:
   a) Removing the defective weld area and rewelding the parent material using the original welding equipment; or
   b) Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.
4) Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion

weld beads as required. Each patch shall extend a minimum of 6 inches beyond all edges of the defects.

5) All repairs shall be measured, located and recorded.

g. Verification of Repairs on Seams: Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

h. Daily Field Installation Reports: At the beginning of each day's work, the Installer shall provide the Owner's Representative with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1) Total amount and location of geomembrane placed;
2) Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3) Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4) Results of pre-qualification test seams;
5) Results of non-destructive testing; and
6) Results of vacuum testing repairs.

3.05 DISPOSAL OF SCRAP MATERIALS

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in an approved offsite location, remove equipment used in connection with the work herein, and leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface and on the wastewater treatment plant site.

3.06 ACCEPTANCE

A. The Contractor shall retain all ownership and responsibility for the liner until accepted by the Owner.

B. The liner shall be accepted by the Owner and Owner's Representative when all of the following conditions are met:

1. Installation is finished.
2. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.
3. Certification, including "record" drawings showing actual layout of sheets and locations of field seams, are provided by the Contractor to the Owner's Representative, and written warranties provided to the Owner's Representative.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Related Specification Sections:

1. Section 03900 - Hydraulic Structures Testing.

2. Section 09900 – Painting and Coatings.

1.02 SUMMARY

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

1. Cast-in-place concrete includes the following:

a) Foundations and footings.

b) Slabs-on-grade.

c) Tank & trench walls.

d) Elevated slabs.

e) Equipment pads and bases.

1.03 SUBMITTALS

A. General: All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

1. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials and others if requested by Engineer.

2. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Shop drawings to show proposed location of all construction joints. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures. Engineer’s review is for general compliance only. The Contractor will be responsible for size, number and lengths of reinforcing.

3. Shop drawings for formwork indicating fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually. Engineer's review is for general applications and features only. Designing formwork for structural stability and efficiency is Contractor's responsibility.

4. The testing laboratory shall submit three (3) copies of results of concrete cylinder tests to Engineer together with one (1) copy each to Owner, Contractor, and Concrete Supplier.

5. Ready-mixed concrete delivered shall be accompanied by delivery tickets showing the following:

   a) Date and time leaving the plant.

   b) Type of cement and weight.

   c) Quantity of water and time added.

   d) Aggregate moisture correction factor.

   e) Admixtures and weight.

   f) Site arrival time.

   g) Site leaving time.

   h) Type of fly ash and weight.

6. Laboratory test reports for concrete materials and mix design test. Contractor shall submit three (3) copies.

7. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

8. Hot weather and cold weather concreting plan shall include curing method and specific curing plan, ready mixed supplier plan, contingency plans and materials list as a minimum. All hot weather plans shall meet requirements of ACI 305. All cold weather plans shall meet requirements of ACI 306.

9. A pouring plan will be submitted by the Contractor to the Engineer for approval showing the location of all construction joints and sawed contraction joints.

1.04 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the latest revision of the following codes, specifications and standards, except where more stringent requirements are shown or specified:

1. American Concrete Institute (ACI) 211 “Proportions for Normal, Heavyweight and Mass Concrete.”

2. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."

3. ACI 318, "Building Code Requirements for Reinforced Concrete."

4. ACI 347 “Recommended Practice for Concrete Formwork.”

5. ACI 350 “Code Requirements for Environmental Engineering Concrete Structures.”

6. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

7. ASTM C 94 Standard Specifications for Ready-Mix Concrete.

8. Florida Building Code 2007 edition.

9. ACI 305 “Specification for Hot Weather Concreting” and 306 “Standard Specification for Cold Weather Concreting.”

B. Concrete Testing Service: Owner will engage a testing agency to perform material evaluation tests.

C. Materials and installed work may require testing and retesting at any time during progress of Work. Any retesting of rejected materials for installed Work, shall be done at Contractor's expense.

D. Review requirements for submittals, status of coordinating work and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

1. Contractor's superintendent.

2. Agency responsible for concrete design mixes.

3. Agency responsible for field quality control.

4. Ready-mix concrete producer.

5. Concrete subcontractor.

6. Primary admixture manufacturers.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

B. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade

or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

C. Forms for Unexposed Finish Concrete: Plywood, lumber, metal or another acceptable material. Provide lumber dressed on at least two (2) edges and one (1) side for tight fit.

D. Forms for Cylindrical Columns and Supports: Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

E. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

F. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.

G. Provide ties that, when removed, will leave holes not larger than 1 inch and no smaller than ½ inch in diameter in the concrete surface. Form ties for exposed concrete shall be of the cone-washer type. The cones shall be made of approved wood or plastic. Ties for liquid containment structures shall have an integral waterstop that is tightly welded to the tie. Common wire will not be allowed for form ties.

2.02 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615 Grade 60 deformed.

B. Steel Wire: ASTM A 82, plain, cold-drawn steel.

C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.

D. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

E. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

F. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.03 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150

1. Type I/II.

B. Fly Ash: ASTM C 618, Class F

1. Use one brand of cement and fly ash throughout Project unless otherwise acceptable to Engineer.

C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.

2.04 WATER

A. Mixing water shall meet specified requirements of ASTM C 94, Section 5.

2.05 ADMIXTURES, GENERAL

Provide concrete admixtures that contain not more than one tenth of one percent (0.1%) chloride ions.

A. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a) Conair, Cormix Construction Chemicals.

b) Air-Mix or Perma-Air, Euclid Chemical Co.

c) Darex AEA or Daravair, W.R. Grace & Co.

d) MB-VR or Micro-Air, Master Builders, Inc.

e) Sealtight AEA, W.R. Meadows, Inc.

f) Sika AER, Sika Corp.

B. Water-Reducing Admixture: ASTM C 494, Type A or D.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a) Chemtard, ChemMasters Corp.

b) PSI N, Cormix Construction Chemicals.

c) Eucon WR-75, Euclid Chemical Co.

d) WRDA, W.R. Grace & Co.

e) Pozzolith Normal or Polyheed, Master Builders, Inc.

f) Metco W.R., Metalcrete Industries.

g) Plastocrete 161, Sika Corp.

C. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a) Super P, Anti-Hydro Company, Inc.

b) Eucon 37, Euclid Chemical Company.

c) WRDA or Daracem, W.R. Grace and Company.

d) Rheobuild or Polyheed, Master Builders, Inc.

e) Superslump, Metalcrete Industries.

f) Sikament, Sika Corp.

2.06 CALCIUM CHLORIDE

A. The use of calcium chloride will not be permitted.

2.07 RELATED MATERIALS

A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217- inch-thick galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized sheet steel, not less than 0.0336 inch thick with bent tab anchors. Fill slot with temporary filler or cover face opening to prevent intrusion of concrete or debris.

C. Waterstops: Provide ribbed-type waterstops at construction joints exposed to water pressure, including groundwater pressure, and other joints as indicated. Provide ribbed type with centerbulb waterstops at expansion joints. In general waterstops shall be 9″ wide. Install 6″ wide waterstops at intersections with reinforced sections with 3″ of clear cover. All waterstops shall be a minimum of 3/8″ thick. All waterstops shall be provided with either metal grommets or integral tie wires located along the top and bottom of the waterstop spaced at 12″. Other styles or sizes of waterstops may be considered based on their specific application.

D. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

a) BoMetals, Inc.

b) The Burke Co.

c) Greenstreak Plastic Products Co.

d) Meadows, Inc.

e) Progress Unlimited.

f) Schlegel Corp.

g) Vinylex Corp.

E. Sand Cushion: Clean, manufactured or natural sand.

F. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:

1. Polyethylene sheet not less than 6 mils thick.

G. Water-resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.

H. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd., complying with AASHTO M 182, Class 2.

I. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.

2. Polyethylene film.

3. Polyethylene-coated burlap.

J. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade and class to suit Project requirements.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a) Burke Epoxy M.V., The Burke Co.

b) Spec-Bond 100, Conspec Marketing and Mfg. Co.

c) Resi-Bond (J-58), Dayton Superior.

d) Euco Epoxy System #452 or #620, Euclid Chemical Co.

e) Epoxtite Binder 2390, A.C. Horn, Inc.

f) Epabond, L&M Construction Chemicals, Inc.

g) Concresive Standard Liquid, Master Builders, Inc.

h) Rezi-Weld 1000, W.R. Meadows, Inc.

i) Metco Hi-Mod Epoxy, Metalcrete Industries.

j) Sikadur 32 Hi-Mod, Sika Corp.

k) Stonset LV5, Stonhard, Inc.

l) Series, Symons Corp.

2.08 PROPORTIONING AND DESIGNING MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301, ACI 211, and ACI 350. For the trial batch method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.

B. Do not use the same testing agency for field quality control testing.

C. Limit use of fly ash to not exceed twenty-five percent (25%) of the total cementitious content by weight. Fly ash shall be used either as an admixture or as a partial cement replacement. Fly ash may be used in all structural concrete.

D. Submit written reports to Engineer of each proposed mix for each class of concrete at least fifteen (15) days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.

2.09 COMPRESSIVE STRENGTHS

A. Design mixes to provide concrete with the following properties as indicated on schedules:

CLASS	7 DAY	28 DAY	MAXIMUM WATER - CEMENTITIOUS RATIO	MINIMUM CEMENTITIOUS MATERIAL (LBS/CY)
Structural	2670	4000	0.44	564
Non-Structural	2000	3000	0.50	470
Structural, High Density	3000	4500	0.40	650

2.10 STRUCTURAL HIGH DENSITY CONCRETE

A. Structural, High Density Concrete shall be used in all structures where concrete is intended to be watertight in service.

2.11 SLUMP LIMITS

A. Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs and sloping surfaces: Not more than 3 inches.

B. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.

C. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2 - 3 inch slump concrete.

2.12 CONCRETE MIX ADJUSTMENTS

A. Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.

2.13 ADMIXTURES

A. Use high-range water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete required to be watertight, and concrete with water-cement ratios below 0.50.

B. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of five percent (5%) with a tolerance of plus or minus one percent (1%).

2.14 READY-MIXED CONCRETE

A. Comply with requirements of ASTM C 94, and as specified.

1. When air temperature is between 85 °F and 90 °F, reduce mixing and delivery time from one and a half (1-1/2) hours to seventy-five (75) minutes, and when air temperature is above 90 °F, reduce mixing and delivery time to sixty (60) minutes.

2.15 WATERPROOFING

A. Provide above and below-grade surface applied coatings in accordance with Project Specification Section 09900.

2.16 CRACK INJECTION MATERIALS

A. Hydrophilic Resin:

1. Shall be a low viscosity, expanding polyurethane resin. It shall cure into a flexible rubber-like material that has the potential for unrestrained increase in volume in excess of 100 percent in the presence of water.

2. Prepare substrate and install in accordance with the manufacturers recommendations.

3. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

a) Sika Injection 29, by Sika Corporation.

b) Duroseal Inject, as manufactured by BBZ USA, Inc.

c) Or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier and other related materials with placement of forms and reinforcing steel.

B. Forms

1. General: Design, erect, support, brace and maintain formwork to support vertical, lateral, static and dynamic loads that might be applied

until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

a) Provide Class A tolerances for concrete surfaces exposed to view.

b) Provide Class C tolerances for other concrete surfaces.

C. Construct forms to sizes, shapes, lines and dimensions shown and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

E. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

F. Chamfer all exposed corners and edges, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints. Chamfer edges to be ¾″ unless otherwise approved by Engineer, or noted on the construction drawings.

G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.02 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.

B. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.

C. Clean reinforcement of loose rust and mill scale, earth, ice and other materials that reduce or destroy bond with concrete.

D. Accurately position, support and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as approved by Engineer.

E. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

F. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one (1) full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.03 JOINTS

A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.

B. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do

not continue reinforcement through sides of strip placements.

C. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's printed instructions.

E. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

F. Joint fillers and sealants shall be as follows:

1. Joint Fillers

a) Self-expanding Cork Joint Filler: Preformed strips complying with ASTM D 1752 for Type III.

b) Cork Joint Filler: Preformed strips complying with ASTM D 1752 for Type II.

c) Sponge Rubber Joint Filler: Preformed strips complying with ASTM D 1752 for Type I.

d) Bituminous Fiber Joint Filler: Preformed strips complying with ASTM D 1751: Granulated cork with asphalt binder encased between two (2) layers of saturated felt of glass-fiber felt of width and thickness indicated.

2. Joint Sealers shall be appropriate for their intended use and installations. Follow manufactures instruction for use and installation. All joint sealants shall be in accordance with ACI 504R.

3.04 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete.

Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.05 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, non-residual, low-VOC, form-coating compound before placing reinforcement.

B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

C. Coat steel forms with a non-staining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.06 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

E. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.

F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate. A spare vibrator will be on-site for emergency use at all times.

G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints or expansion joints, until completing placement of a panel or section.

H. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.

I. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

J. Maintain reinforcing in proper position on chairs during concrete placement.

K. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

L. When air temperature has fallen to or is expected to fall below 40 °F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 °F and not more than 80 °F at point of placement.

M. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

N. Do not use salt, other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs. Calcium chloride will not be allowed.

O. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

P. Cool ingredients before mixing to maintain concrete temperature at time of placement to be in accordance with ACI. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Ice can not be used to replace more than half of the design total water content. Using liquid nitrogen to cool concrete is Contractor's option.

Q. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.

R. Fog spray forms, reinforcing steel and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.

S. Use water-reducing retarding admixture when required by high temperatures, low humidity or other adverse placing conditions, as acceptable to Engineer.

3.07 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off. Finish shall be a Class C in accordance with ACI 347.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting or another similar system. This is an as-cast concrete surface obtained with selected

form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed. Finish shall be a Class A in accordance with ACI 347.

C. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

1. Combine one part Portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.

2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least thirty-six (36) hours after rubbing.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

E. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 25 (floor flatness) and F(L) 20 (floor levelness) measured according to ASTM E 1155 (ASTM E 1155M). Cut down high spots

and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Class of surface shall be a class C surface in accordance with 347 R.

F. Non-slip Broom Finish: Apply a non-slip light broom finish to exterior concrete platforms, steps and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

G. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work. All grout shall be non-shrinking.

H. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections and terminations slightly rounded.

I. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

J. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp and non-slip broom concrete surfaces.

K. Below Grade Concrete: Waterproof the exterior (grade) side of tank and building walls. Prepare surface based upon manufacturers recommendations. Material may be spray, brush or roller applied. Conform to manufacturers recommendations for chosen application.

3.08 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Keep continuously moist for not less than fourteen (14) days as required due to weather.

C. Curing Methods: Cure concrete by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.

1. Provide moisture curing by the following methods:

a) Keep concrete surface continuously wet by covering with water.

b) Use continuous water-fog spray.

c) Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4 inch lap over adjacent absorptive covers.

2. Provide moisture-retaining cover curing as follows:

a) Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. As soon as initial set has occurred, place a soil soaker hose along the

tops of all walls to keep concrete forms wet during the curing period. If forms are removed, continue curing by methods specified above, as applicable, for the remainder of the curing period. If forms are removed before the end of the curing period, then the concrete shall be continuously moist for the remainder of the curing period by fog spraying or covering with moist burlap.

4. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping and other flat surfaces, by applying the appropriate curing method.

5. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.09 SHORES AND SUPPORTS

A. General: Comply with ACI 347 for shoring and reshoring in multistory construction, and as specified.

B. Extend shoring from ground to roof for structures four (4) stories or less, unless otherwise permitted.

C. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to support work without excessive stress or deflection.

D. Keep reshores in place a minimum of fifteen (15) days after placing upper tier, or longer, if required, until concrete has attained its required twenty-eight (28) day strength and heavy loads due to construction operations have been removed.

3.10 REMOVING FORMS

A. Formwork, such as columns, beam soffits, elevated slabs, joists, walls and other structural elements, may not be removed until concrete has attained at least seventy percent (70%) of design minimum compressive strength at twenty-eight (28) days. No earth loads or live loads will be structurally placed against or on any poured structurally reinforced concrete until the concrete has reached its twenty-eight (28) day compressive strength or otherwise approved by the Engineer. Determine potential compressive strength of

in-place concrete by testing field-cured specimens representative of concrete location or members.

B. Form-facing material may be removed four (4) days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.11 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Engineer.

3.12 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Engineer.

B. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

C. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope

and smoothness by using a template having the required slope.

E. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets and other objectionable conditions.

F. Correct high areas in unformed surfaces by grinding after concrete has cured at least fourteen (14) days.

G. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Engineer.

H. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

I. Additional repair of concrete cracks in formed and unformed surfaces: All concrete for liquid retaining structures, elevated slabs subject to rainfall and washdown, below grade members and all concrete in contact with earth, water or exposed directly to the elements shall be watertight. All leaks through concrete that exhibit any dampness or flowing water and any cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by CONTRACTOR. Where it is not possible to verify that a crack is not leaking, it shall be repaired. Determination of leakage and / or dampness shall be made by Engineer. Repair, removal, and replacement of defective concrete as directed by ENGINEER shall be at no additional cost to the OWNER.

1. Method of Repair: Cracks shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.

3.13 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General: The Contractor will employ a testing agency to perform tests and to submit test reports. The testing agency shall be approved by the Engineer. Any retesting due to non-acceptable work or materials shall be at the Contractors expense.

B. Sampling and testing for quality control during concrete placement may include the following, as directed by Engineer.

C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

D. Slump: ASTM C 143; one (1) test at point of discharge for each compressive strength test; additional tests when concrete consistency seems to have changed or as directed by the Engineer.

E. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one (1) for each compressive strength test.

F. Concrete Temperature: ASTM C 1064; one (1) test hourly when air temperature is 40 °F and below, when 90 °F and above, and one (1) test for each set of compressive-strength specimens.

G. Compression Test Specimen: ASTM C 31; one (1) set of four (4) standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.

H. Compressive-Strength Tests: ASTM C 39; one (1) set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one (1) day; one (1) specimen tested at seven (7) days, two (2) specimens tested at twenty-eight (28) days, and one (1) specimen retained in reserve for later testing if required.

I. When frequency of testing will provide fewer than five (5) strength tests for a given class of concrete,

conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.

J. When strength of field-cured cylinders is less than eighty-five percent (85%) of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

K. Strength level of concrete will be considered satisfactory if averages of sets of three (3) consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

L. Test results will be reported in writing to Engineer, ready-mix producer, and Owner within twenty-four (24) hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at twenty-eight (28) days, concrete mix proportions and materials, compressive breaking strength, and type of break for both seven (7) day tests and twenty-eight (28) day tests.

M. Nondestructive Testing: Impact hammer, sonoscope or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

N. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. These additional tests shall be at the Contractor’s expense.

3.14 TEST FOR WATERTIGHTNESS (HYDRAULIC STRUCTURES)

A. All concrete tanks and structures designed to contain liquid shall be tested for watertightness in accordance with Section 03900 – Hydraulic Structures Testing

END OF SECTION

SECTION 03455

PRECAST CONCRETE MANHOLES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all materials, labor and equipment and construct manholes consisting of precast sections as shown on the Drawings and as specified herein.

B. The manholes shall have an invert channel shaped to correspond with the lower half of the pipe. The top of the shelf shall be sloped to drain toward the flowing channel. Every effort shall be made by the Contractor to construct watertight structures. Structures that are not watertight or do not meet the requirements of ASTM C-433 are unacceptable.

C. The forms, dimensions, concrete and construction methods shall be available for inspection by the Owner's Representative in advance of construction. The Owner's Representative shall reserve the right to inspect the facilities of the manufacturer.

D. Flexible gasket connectors for connecting pipes shall meet the requirements of ASTM C-443 or latest revision, and are required in all manholes.

E. Lifting devices shall not penetrate the walls of the manholes.

1.02 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

B. Submit shop drawings showing details of construction, reinforcing, joints, buoyancy calculations, openings and all other specified details.

1.03 INSPECTION

A. The quality of all materials, the process of manufacture and the finished sections shall be subject to inspection and approval by the Owner's Representative. Such inspection may be made at the place of manufacture, and/or at the site. Wherever possible, the precast sections shall be inspected prior to unloading from the

delivery truck and marked by the inspector showing acceptance or rejection. However, discovery at any time of failure to meet requirements of these Specifications is cause for rejection.

B. Sections rejected after delivery to the job shall be marked for identification and shall be removed from the job site at once. All sections which are damaged after delivery, will be rejected and if already installed, shall be acceptably repaired, if permitted, or removed and replaced entirely at the Contractor's expense, as determined by the Owner’s Representative.

C. All sections shall meet the manufacturing tolerance requirements of ASTM C-478 or the following casting tolerances, whichever are more severe:

Wall Thickness	± 3/8"
Inside Diameter	± 3/8"
Outside Diameter	+ 1/2"
Height or Length	+ 3/8"

D. Pipe openings shall meet the recommended tolerances of the individual manufactured pipe to manhole connectors; however, the horizontal location shall be within ± 2 degrees of arc of that detailed on shop drawings.

E. At the time of inspection, the sections will be carefully examined for compliance with ASTM C478 latest revision, these Specifications and the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

F. Imperfections may be repaired subject to the approval of the Owner’s Representative after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at 7 days and 5,000 psi at 28 days. Epoxy mortar may be utilized for repairs subject to the approval of the Owner’s Representative.

PART 2 PRODUCTS

2.01 PRECAST CONCRETE SECTIONS

A. General

1. Except as modified in the Specifications, manholes shall meet the requirement of ASTM C478, most recent revision, Specification for Precast Reinforced Concrete Manhole Sections. Cement shall meet the requirements of ASTM C150, or most recent revision, Specification for Portland Cement, Type II. Concrete shall have a compressive strength of 4,000 psi. Minimum wall thickness for manholes shall be 8" or 1/12 the inside manhole diameter, whichever is greater. Sections shall be custom made with openings to meet indicated pipe alignment conditions and invert elevations. Contractor shall submit shop drawings, consisting of manufacturer's standard details of various sections, for approval prior to manufacture. Drawings of individual manholes showing invert elevations, pipe sizes and similar details are required. Manufacturer shall submit concrete mix designs together with certified test results for the Engineer's review prior to commencing manufacture.

2. Manufacturer shall make a minimum of four standard test cylinders for each 100 cubic yards of concrete (or part thereof) that is cast each day. These test cylinders, along with sections cast that day, shall be marked in such a way that the test results can be matched with the appropriate castings. Two cylinders shall be cured with the product until the forms are stripped. At this time, one cylinder shall be broken to ascertain that a minimum strength of 2000 psi has been reached prior to moving the product from the forming location. The remaining two cylinders shall be cured and tested in accordance with ASTM C192-81 and C39-84. The average compressive strength for each day's production shall be greater than 4000 psi with no more than 10% of the tested cylinders falling below 4000 psi. In no case shall any cylinder strength fall below 3500 psi. All cylinder strengths shall be certified by a Florida Licensed Professional Engineer. Failure to meet these requirements for any day's production is cause for rejection of all sections cast that day.

3. The Manufacturer shall design the manholes with sufficient volumes of concrete to keep the manholes from floating assuming that groundwater is at the

surface of the ground. The Manufacturer shall provide design calculations signed and sealed by a professional engineer to the Owner that prove that the manholes cannot float.

B. Joints

1. Form joint contact surfaces with machined castings. Surfaces shall be parallel and the tongue equipped with a proper recess for the installation of a rubber gasket. Gaskets shall meet the requirements of Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (ASTM C-443). In addition to this rubber gasket joint, the installation contractor may, at his own choice, add an exterior seal such as "Waterstop Rx", "Adeka Ultra Seal" or "Cadilloc Sealing Bands".

C. Masonry for Grade Adjustment

1. Precast grade rings or brick shall be used for final grade adjustment. Bricks shall be wetted prior to laying. Bricks shall be set true to line with each coarse plumb. No mortar shall be used which has begun to set. The grade rings or bricks used on manholes with fiberglass linings shall also be protected in the same manner.

D. Masonry

1. Brick: ASTM C32 most recent revision, Specification for Sewer and Manhole Brick (made from clay or shale). Sound, hard and uniformly burned, regular and uniform in shape and size of compact texture. Grade MA.

2. Cement: Portland, ASTM C150-180 most recent revision, Specification for Portland Cement, Type II. Approved: Atlas Florida; Lehigh.

3. Sand: Washed silica sand, ASTM C144, latest revision. Specification for Aggregate for Masonry Mortar.

E. Invert Construction

1. Inverts: Use precast preformed inverts from the manufacturer constructed specifically for each manhole or form with Type II cement and sand mortar and brick to provide a smooth flowing channel of similar shape and size of the sewer to which it connects.

2. Straight Run Manholes: Shape inverts while manholes are under construction. Cut off pipe at inside face of manhole and construct invert to exact shape and size of pipe indicated.

3. Junction Manholes: Shape inverts while manholes are under construction. Cut off pipe at inside face of manhole and construct invert to shape and size of pipe indicated. All inverts shall follow grades of pipes entering manholes. Provide a true curve of the largest radius possible for changes in direction of sewer and entering branch or branches.

F. Manhole Frames and Lids

1. ASTM A48 most recent revision, Specification for Gray Iron Castings, Class 30 or Grade 60-45-10 Ductile Iron meeting the requirements of ASTM A536 most recent revision, Specification for Ductile Iron Castings. Cast in a true symmetrical pattern of tough, dense and even grained iron, free from warping, scales, lumps, blisters, sandholes, or any defects of any kind. Provide indented pattern lids with lettering as shown on the Drawings. Machine or grind frames and lids at touching surfaces to provide firm seats and prevent rocking. Remove and replace any set not matching perfectly. All frames and covers shall be designed to withstand an HS20-44 wheel loading as defined by AASHTO specifications.

G. Protective Coating

1. A coal tar epoxy protective coating shall be applied to interior and exterior walls of manholes. Two coats each shall be applied to the inside and outside. Each coat shall yield a final dry film thickness of 9 mils for a total thickness of 18 mils. Coating shall be Tnemec Polyamide Epoxy-Coal Tar 46H-413, or approved equal.

PART 3 MANHOLE CONSTRUCTION

3.01 PRECAST CONCRETE MANHOLE INSTALLATION

A. Precast concrete sections shall be set vertical and in true alignment. Rubber gaskets shall be installed in the previously set sections. All manholes shall meet the following installation tolerances:

1. The finished manholes shall not be out of plumb by more than 3/8" per 10 feet of height. For manholes exceeding 40'-0" high, the variation from plumb shall not exceed 1-1/2".

2. Any jog or offset of wall surface each side of a joint shall not exceed 1/2".

3. Variation in the joint width around the circumference of the manhole shall not exceed 3/8".

4. Lifting holes in the concrete sections required for handling or other purposes shall be plugged with a non-shrink grout or by grout in combination with concrete plugs.

3.02 GRADE ADJUSTMENT

A. Brick masonry shall be erected or precast concrete grade rings shall be set on top of manhole slabs and precast concrete manhole cones to provide grade adjustment in setting manhole frames.

3.03 SETTING MANHOLE FRAMES

A. Manhole frames and lids shall be set to conform accurately to the finished ground or pavement grade as shown on the Drawings or as directed by the Owner’s Representative. Frames on manholes shall be set concentric with the masonry and in a full bed or mortar so that the space between the top of the manhole masonry and the bottom flanges of the frame will be completely filled and made watertight. A ring of mortar shall be placed around the outside of the bottom flange at least one inch thick and pitched to shed water away from the frame. Mortar shall be extended to the outer edge of the masonry and finished smooth and flush with the top of the flange.

3.04 TESTING

A. After construction to its finished height and before being backfilled, each manhole shall be tested for water tightness in one of the following manners:

1. Plug holes and fill the manhole with clean water. After eight hours, the water level shall be checked for loss of water. This loss shall not exceed 0.05 gals/hr/ft.dia/ft. head and for a 4'-0" diameter manhole, the allowable level change is shown in the following table:

Allowable Drop in Water Level of 4'-0" Dia. Manholes

Head of Water Ft.	Level Drop Inches
4	0.8
5	1.0
6	1.2
7	1.4
8	1.6
10	2.0
12	2.45
16	3.3
20	4.0
24	4.9

2. Plug pipe lines and perform vacuum test. Observing all recommended safety measures induce a backpressure of 5.0 p.s.i. equivalent to 10" Hg (mercury). The manhole assembly is considered satisfactory if the vacuum loss is less than 1" Hg for the length of time listed in the following table:

Time of Test in Seconds

Depth Feet	Manhole Diameter Feet 4	5	6
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
T	5	6.5	8

Note: Add "T" seconds for each additional 2'-0" of depth.

B. Failure to pass one of these tests requires the contractor to correct the problems and retest. The Contractor will replace leaking gaskets and/or concrete sections and retest the completed manhole. No manhole

will be accepted without successfully passing one of these tests.

3.05 CONNECTION TO EXISTING MANHOLES

A. The Contractor shall connect, where shown on the Drawings or directed by the Owner’s Representative, new lines into existing manholes. Unless existing stubs of correct size and location are found to exist, he shall remove a portion of the manhole wall masonry. All new piping entering existing manholes shall be accomplished by mechanical rotary core boring of the manhole riser. After installation of piping, the annular space between piping and concrete shall be sealed with "Link-Seal" "Thunderline Seals" or approved equal.

END OF SECTION

SECTION 03456

PRECAST CONCRETE WETWELL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all materials, labor and equipment and construct precast concrete cylindrical wetwells for the Reclaimed Water Return Pump Station for the North Pond and for the Waste Backwash Pump Station at the Disk Filters, consisting of precast sections as shown on the Drawings and as specified herein. The RCWR Pump Station shall have an inside diameter of 12 feet, and the BWW Pump Station an inside diameter of 6 feet.

B. The wetwells shall have sloping sides shaped to drain towards the suction inlets of the pumps. Every effort shall be made by the Contractor to construct a watertight structure. Structures that are not watertight or do not meet the requirements of ASTM C-433 are unacceptable.

C. The forms, dimensions, concrete and construction methods shall be available for inspection by the Owner’s Representative in advance of construction. The Owner’s Representative shall reserve the right to inspect the facilities of the manufacturer.

D. Lifting devices shall not penetrate the walls of the precast concrete wetwells.

1.02 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

B. Submit shop drawings showing details of construction, reinforcing, joints, buoyancy calculations, openings and all other specified details.

1.03 INSPECTION

A. The quality of all materials, the process of manufacture and the finished sections shall be subject to inspection and approval by the Owner’s Representative. Such inspection may be made at the place of manufacture, and/or at the site. Wherever possible, the precast sections shall be inspected prior to unloading from the delivery truck and marked by the inspector showing acceptance or rejection. However, discovery at any time

of failure to meet requirements of these Specifications is cause for rejection.

B. Sections rejected after delivery to the job shall be marked for identification and shall be removed from the job site at once. All sections which are damaged after delivery, will be rejected and if already installed, shall be acceptably repaired, if permitted, or removed and replaced entirely at the Contractor's expense, as determined by the Owner’s Representative.

C. All sections shall meet the manufacturing tolerance requirements of ASTM C-478 or the following casting tolerances, whichever are more severe:

Wall Thickness	± 3/8"
Inside Diameter	± 3/8"
Outside Diameter	+ 1/2"
Height or Length	+ 3/8"

D. Pipe openings shall meet the recommended tolerances of the individual manufactured pipe to wetwell connectors; however, the horizontal location shall be within ± 2 degrees of arc of that detailed on shop drawings.

E. At the time of inspection, the sections will be carefully examined for compliance with ASTM C478 latest revision, these Specifications and the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

F. Imperfections may be repaired subject to the approval of the Owner’s Representative after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at 7 days and 5,000 psi at 28 days. Epoxy mortar may be utilized for repairs subject to the approval of the Owner’s Representative.

PART 2 PRODUCTS

2.01 PRECAST CONCRETE SECTIONS

A. General

1. Except as modified in the Specifications, the wetwells shall meet the requirements of ASTM C478, most recent revision, Specification for Precast Reinforced Concrete Wetwell Sections. Cement shall meet the requirements of ASTM C150, or most recent revision, Specification for Portland Cement, Type II. Concrete shall have a compressive strength of 4,000 psi. Minimum wall thickness for the 12–foot diameter wetwell shall be 12 inches, and for the 6-foot diameter wet well shall be 8 inches. Sections shall be custom made with openings to meet indicated pipe alignment conditions and invert elevations. Contractor shall submit shop drawings, consisting of manufacturer's standard details of various sections, for approval prior to manufacture. Drawings of the wetwells showing invert elevations, pipe sizes and similar details are required. Manufacturer shall submit concrete mix designs together with certified test results for the Owner’s Representative’s review prior to commencing manufacture.

2. The Manufacturer shall design the wetwells with sufficient volumes of concrete to keep the wetwells from floating, assuming that groundwater is at the surface of the ground. The Manufacturer shall provide design calculations to the Owner that prove that the wetwells cannot float.

3. Manufacturer shall make a minimum of four standard test cylinders for each 100 cubic yards of concrete (or part thereof) that is cast each day. These test cylinders, along with sections cast that day, shall be marked in such a way that the test results can be matched with the appropriate castings. Two cylinders shall be cured with the product until the forms are stripped. At this time, one cylinder shall be broken to ascertain that a minimum strength of 2,000 psi has been reached prior to moving the product from the forming location. The remaining two cylinders shall be cured and tested in accordance with ASTM C192-81 and C39-84. The average compressive strength for each day's production shall be greater than 4,000 psi with no more than 10% of the tested cylinders falling below 4,000 psi. In no case shall any cylinder strength fall below 3,500 psi. All cylinder strengths shall be certified by a Florida Licensed Professional Engineer. Failure to meet these requirements for

any day's production is cause for rejection of all sections cast that day.

B. Joints

1. Form joint contact surfaces with machined castings. Surfaces shall be parallel and the tongue equipped with a proper recess for the installation of a rubber gasket. Gaskets shall meet the requirements of Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (ASTM C-443). In addition to this rubber gasket joint, the installation contractor may, at his own choice, add an exterior seal such as "Waterstop Rx", "Adeka Ultra Seal" or "Cadilloc Sealing Bands".

C. Bottom Base Internal Construction

1. Use grout to construct sloping sides in the wetwells that channel the water flow to the suction inlets of the submersible pumps. Use grout to construct benches to support the discharge elbows for the pumps.

D. Aluminum Access Hatches

1. The Contractor shall provide an aluminum access hatch for each pump in the top slab of the concrete wetwells. Each access hatch shall have dimensions recommended by the pump manufacturer. Each aluminum access hatch and frame shall be fabricated as specified in Section 05531. Each access hatch and frame shall be designed to support a loading of 300 pounds per square foot.

E. Protective Coatings

1. A coal tar epoxy protective coating shall be applied to interior and exterior walls of the wetwells. Two coats shall be applied to the inside, and one coat shall be applied to the outside. Each coat shall yield a final dry film thickness of 9 mils. Coating shall be Tnemec Polyamide Epoxy-Coal Tar 46H-413, or approved equal.

PART 3 WETWELL CONSTRUCTION

3.01 PRECAST CONCRETE WETWELL INSTALLATION

A. Precast concrete sections shall be set vertical and in true alignment. Rubber gaskets shall be installed in the previously set sections. The wetwell shall meet the following installation tolerances:

1. The finished wetwell shall not be out of plumb by more than 3/8" per 10 feet of height.

2. Any jog or offset of wall surface each side of a joint shall not exceed 1/2".

3. Variation in the joint width around the circumference of the wetwell shall not exceed 3/8".

4. Lifting holes in the concrete sections required for handling or other purposes shall be plugged with a non-shrink grout or by grout in combination with concrete plugs.

3.02 TESTING

A. After construction to their finished heights and before being backfilled, the wetwells shall be tested for water tightness in one of the following manners:

1. Plug holes and fill the wetwell with clean water. After eight hours, the water level shall be checked for loss of water. This loss shall not exceed 0.05 gals/hr/ft.dia/ft. head.

2. Plug pipe lines and perform vacuum test. Observing all recommended safety measures, induce a backpressure of 5.0 p.s.i. equivalent to 10" Hg (mercury). The wetwell assembly is considered satisfactory if the vacuum loss is less than 1" Hg for a 60 second length of time.

B. Failure to pass one of these tests requires the contractor to correct the problems and retest. The Contractor shall replace leaking gaskets and/or concrete sections and retest the completed wetwell. The wetwell will not be accepted without successfully passing one of these tests.

3.03 CONNECTION TO EXISTING MANHOLES

A. The Contractor shall connect, where shown on the Drawings or directed by the Owner’s Representative, new lines into existing manholes. Unless existing stubs of

correct size and location are found to exist, he shall remove a portion of the manhole wall masonry. All new piping entering existing manholes shall be accomplished by mechanical rotary core boring of the manhole riser. After installation of piping, the annular space between piping and concrete shall be sealed with "Link-Seal" or, approved equal.

END OF SECTION

SECTION 03600

GROUTING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. This Section includes grouting of equipment bases and such locations as shown on the Drawings and as specified.

B. The types of grouting include the following:

1. Portland Cement Grout

2. Non-shrink, Non-expanding Grout

1.02 DELIVERY AND STORAGE

A. Prevent damage to or contamination of grouting materials during delivery, handling and storage.

B. Store all grouting materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.03 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

PART 2 PRODUCTS

2.01 PREMIXED GROUTS

A. Portland Cement Grout

B. (For grouting CMU cells and similar items – f’c=3000 psi minimum)

1. Portland Cement: ASTM C150, Type I

2. Sand: ASTM C33, Fine Aggregate

3. Water: Potable

4. Pea Gravel: ASTM C33. Coarse aggregate, graded so that at least 90% passes 3/8-inch sieve and 90% is retained by a number 4 sieve.

C. (Grout Mortar for use as fillets and leveling)

1. Portland Cement: ASTM C150, Type I

2. Sand: ASTM C33, Fine Aggregate (Marson's sand)

3. Water: Potable

4. Mix 1-part Portland cement to 3-parts sand.

D. Pre-Mixed non-shrink, Non-expanding Grout (Nonmetallic). Non-shrink grout as shown on the Drawings shall be a mixture of selected silica sands, Portland cement, water reducing agents, plasticizing and shrinkage compensating agents. Grout shall be nonmetallic non-corrosive, non-staining and comply with CRD-C-588, Type D.

E. The grout shall be non-shrink in accordance with ASTM C827, ASTM C191, and ASTM C109. The water-grout ratio shall be approximately 8 to 10 quarts of water per cubic foot of grout adjustable for varying job conditions.

F. Grout shall not contain calcium chloride or other salt; aluminum or other metals; chemical additives, gypsum or expansive cements. Grout shall not expand after set.

G. Grout shall be used and applied in accordance with the manufacturer's written instructions.

H. Subject to compliance with requirements provide from the following:

1. L&M Construction Chemicals, Inc. – Crystex

2. Grout Corp. - Five Star Non-shrink Grout or equivalent

2.02 NONSHRINK GROUT

A. Non-shrink grout shall conform to the following requirements:

1. Manufactured under rigid quality control specifically for grout used in transferring heavy loads.

2. Contain nonmetallic aggregates specially graded to minimize bleeding.

3. Have an initial setting time of approximately one hour at 70°F.

4. Produce no settlement or drying shrinkage at 3 days or later.

5. Have higher strength at all ages than plain cement grout of the same flowability.

6. Resist attack by oil and water and have lower absorption than plain cement grout of the same flowability.

7. Minimum compressive strength, in accordance with ASTM C-109, shall be 2500 psi after 1 day and 7000 psi after 28 days.

2.03 MIXES

A. For less than 2-inch clearance, or where size or shape of space makes grouting difficult, grout mix shall consist of Portland cement, fine aggregate and water.

B. For greater than 2-inch clearances where coarse aggregate will not obstruct free passage of the grout, extend grout by adding 50 pounds of pea gravel per 100 pounds grout material.

C. Use minimum amount of water necessary to produce a flowable grout without causing either segregation or bleeding.

D. Portland cement mortar for raked-out edges of non-shrink grout: one part Portland cement, two parts sand and 0.50 part water by weight.

2.04 MIXING

A. Mix grout in accordance with manufacturer’s printed specifications.

B. Mix grouting materials and water in a mechanical mixer for no less than 3-minutes.

C. Mix grout as close to the work area as possible and transport the mixture quickly and in a manner that does not permit segregation of materials.

D. After the grout has been mixed, do not add more water for any reason.

PART 3 EXECUTION

3.01 PROCEDURES

A. Installation methods and procedures shall be approved by Engineer and shall be in accordance with manufacturer’s printed specifications before work is begun.

3.02 SURFACE PREPARATION

A. Surface preparation shall be in accordance with manufacturer’s printed specifications.

B. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by bush-hammering, chipping, or other similar means, until a sound, clean concrete surface is achieved.

C. Lightly roughen the concrete, but not enough to interfere with the proper placement of grout. Cover concrete areas with waterproof membrane until ready to grout. Immediately before grouting remove waterproof membranes and clean any contaminated surfaces.

D. Remove foreign materials from metal surfaces in contact with grout. Align, level and maintain final positioning of all components to be grouted.

E. Saturate concrete surfaces with clean water; remove excess water and leave none standing.

3.03 PLACING

A. Placing shall be in accordance with manufacturer’s printed specifications.

B. Place non-shrink grouting material quickly and continuously by the most practical means permissible; pouring, pumping or under gravity pressure.

C. Do not use either pneumatic-pressure or dry packing methods without written permission of the Engineer.

D. Apply grout from one side only to avoid entrapping air.

E. Final installation shall be thoroughly compacted and free from air pockets.

F. Do not vibrate the placed grout mixture or allow it to be placed if the area is being vibrated by nearby equipment.

G. Do not remove leveling shims for at least 480 hours after grout has been placed. After shims have been removed, fill voids with plain cement-sand grout.

H. After non-shrink grout has reached initial set, rake out exposed edges approximately 1-inch into the grouted area and paint with Portland cement mortar.

3.04 CURING

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

END OF SECTION

SECTION 03900

HYDRAULIC STRUCTURES TESTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope

1. The Contractor shall perform cleaning, flushing and testing for all hydraulic structures in accordance with the requirements of the Contract Documents.

2. The Work shall include all labor and materials required to prepare a structure for testing and to convey reclaimed water to the point of use from the source designated by Owner, and all labor and materials required to drain, and dispose of reclaimed water used for testing.

B. Related Divisions and Sections

1. Section 03300 – Cast-In-Place Concrete.
2. Section 03456 – Precast Concrete Wetwell.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following unless otherwise shown or specified.

1. ACI 350, “Code Requirements for Environmental Engineering Concrete Structures and Commentary (ACI 350R).”

1.03 CONTRACTOR SUBMITTALS

A. All submittals. The Contractor shall submit a minimum fourteen (14) day advance written notice of the proposed testing schedule for a given structure for review and concurrence of the Engineer and Owner. The Contractor's proposed plans for water conveyance, control and disposal shall also be submitted in writing.

B. Contractor shall submit all testing data collected for each structure/cell tested in accordance with ACI 350 for approval.

C. All submittals for this Specification shall be in accordance with Section 01340 – Shop Drawings, Project Data and Samples.

PART 2 PRODUCTS

2.01 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads or other water control equipment and materials, shall be as determined by the Contractor subject to the Owner's Representative review. Cost of all materials required for testing, supply and discharge of testing water shall be included in the Base Bid.

PART 3 EXECUTION

3.01 GENERAL

A. Reclaimed water for testing will be furnished by the Owner. The Contractor shall make all necessary provisions for conveying the reclaimed water from the source to the points of use.

B. All hydraulic structures and appurtenant pressure piping connections shall be tested.

C. Concrete coatings, paint and/or liners shall not be applied until all leak testing operations have been completed and the structure is accepted.

D. Release of water from structures, after testing has been completed, shall be as approved by the Owner's Representative. Discharge location shall be approved by Owner.

E. Clean structures after testing and prepare substrates for coating installation in accordance with relevant specification sections.

3.02 LEAKAGE TESTING OF HYDRAULIC STRUCTURES

A. Analysis of data from leakage tests of hydraulic structures will be performed by the Contractor

following the requirements of ACI 350, ACI 350R and as specified herein. The Contractor shall supply all materials and labor as needed to assist the Owner's Representative in obtaining data from the test.

B. Prior to the start of leakage testing, the following requirements shall be met.

1. All elements of the structure that resist any portion of the retained liquid pressure shall be in place and at specified strength levels. All concrete shall be fully cured.

2. Structure walls shall not be backfilled prior to leakage testing.

3. All valves, gates, blind flanges and other non-concrete items that control the flow of, or otherwise retain the liquid contents of the structure, shall be checked for water-tightness. If not watertight, means shall be taken to assure water-tightness during the period of the leakage test.

4. The portions of the structure to be tested shall be cleaned of all construction debris and other foreign materials.

5. Defective concrete shall be repaired.

6. Standing water, soil, construction materials and any other material that interferes with the exposed concrete surfaces of the structure shall be removed.

7. The Contractor shall notify the Owner's Representative and Owner a minimum of seventy-two (72) hours prior to start of filling of structure for leakage testing. Leakage testing shall not start until the structure is inspected by the Owner's Representative.

8. The structure shall be tested prior to the application of all coating systems and the installation of masonry block veneer, if applicable.

C. The following special requirements apply:

1. All structures which contain basins, channels and/or chambers that are independent or are separated by a common wall shall be tested independently unless otherwise agreed to by Engineer. All leakage occurring between/through common walls shall be repaired in addition to all other repair requirements.

2. Each influent, effluent or overflow trough shall be tested independently.

D. Filling Structure with Reclaimed Water:

1. The portion of the structure to be tested shall be filled at a rate not to exceed 2 feet per hour.

2. Structure shall be filled to the normal operating depth of the structure as indicated on the Contract Drawings. Where no operating depth is indicated or where operating depth is controlled by flowing over a weir, the structure shall be filled to a depth 6 inches below the weir or top of wall elevation, whichever is lower.

3. Reclaimed water in the structure shall be maintained at the specified test elevation for a minimum of three (3) days.

E. After reclaimed water has been brought to the test elevation, the exposed elements of the structure shall be inspected for leakage. All locations that exhibit any amount of leakage flow or dampness shall be repaired prior to the start of leakage testing. Dampness is defined as any visible water staining the following:

1. At Exterior Walls – the exterior sides of the walls.

2. At Interior Walls – the opposite sides of the walls containing the water.

F. Leakage test duration shall be determined by the Owner’s Representative based on ACI 350.1R but shall not be less than three (3) days.

G. Leakage Allowance:

1. For concrete structures, the maximum allowable leakage rate shall be 0.075 percent of the volume per twenty-four (24) hour period.

H. Test Locations:

1. Structure cells which are less than 1000 square feet in area shall have measurements of water level taken at two (2) locations that are located approximately 180 degrees apart.

2. Structure calls which are greater than 1000 square feet in area shall have measurements of water level taken at four (4) locations that are located approximately 90 degrees apart.

3. Each test location shall be marked and given a reference number. A reference point shall be marked on the face of the wall above the test water surface in a manner that will prevent its movement or deterioration during the period of the test.

I. Evaporation and Precipitation Measuring:

1. In open structures, a clear plastic calibrated open top container not less than 18 inches in diameter and depth shall be partially filled, floated in the tank, and held in position near each measurement location.

2. The container shall be located so as to not be shaded by tank walls and away from any items passing over it such as beams or pipes.

J. Test Measurements:

1. Leakage tests shall not be started when periods of severe weather conditions or major changes in average daily temperature are predicted.

2. The following measurements shall be recorded at each test location at the start of the test period and at twenty-four (24) hour intervals thereafter.

a) Distance from reference point to test water surface.
b) Depth of reclaimed water in the floating container.

c) Temperature of the test reclaimed water at 18 inches below water surface.

d) Temperature of the reclaimed water in the evaporation-precipitation container at mid-depth.

K. Leakage Determination:

1. The change in water surface elevation at each test location shall be averaged and adjusted as follows:

a) The total change in test water surface elevation shall be adjusted by the average change in water surface elevation in the evaporation-precipitation containers.

b) Where averaged water temperature measurements vary by more than 3 degrees from start to completion of the test period, adjustment in tank volume shall be determined by change of water density resulting from the change in the average water temperature.

L. Retesting:

1. The leakage test shall be considered as failed if the specified leakage allowance is exceeded or if any leakage or dampness is observed.

2. If the test becomes unreliable due to excessive precipitation or other external factors, it shall be restarted.

3. If a leakage test fails, it may be retested immediately without repairs if approved by the Owner’s Representative. If subsequent leakage tests fail, the Contractor shall repair all probable areas of leakage and the leakage test shall be repeated until it meets the specified leakage criteria.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Metal fabrications include items made from iron, steel or aluminum shapes, plates, bars, strips, tubes, pipes and castings which are not specified elsewhere.

B. Extent of metal fabrications is indicated on the drawings or as required to complete the work.

1.02 RELATED SECTIONS

A. Painting metal items is specified in Section 09900 – Painting and Coatings.

1.03 TYPES OF WORK

A. Types of work in this section include metal fabrication for:

1. Miscellaneous framing and supports.

2. Miscellaneous castings.

3. Fasteners.

1.04 SHOP ASSEMBLY

A. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.05 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

B. Product Data: Submit manufacturer's specifications, anchor details and installation instructions for products used in miscellaneous

metal fabrications, including paint products and grout.

C. Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal fabrications including but not limited to rain diverters and prefabricated steel tank cradles. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others.

PART 2 PRODUCTS

2.01 ALUMINUM STAIRS

A. Stairs shall be of aluminum construction with stringers and treads as shown. Treads shall have non-skid surface with abrasive nosing.

2.02 FERROUS METALS

A. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled names and roughness.

B. Steel Plates, angles, channels and Bars: ASTM A 36 with minimum yield strength (Fy=36ksi). Item requiring to be galvanized to be Hot Dipped Galvanized - 2 Oz. per SF.

C. Wide Flange Sections: ASTM A 572 (Fy=50ksi).

D. Steel Tubing: Cold-formed, ASTM A 500, Grade B (Fy=46 ksi).

E. Steel Pipe: Standard weight Schedule 40, ASTM A53, Grade B (Fy=35 ksi).

F. Gray Iron Castings: ASTM A 48, Class 30.

2.03 ALUMINUM METALS AND FABRICATIONS

A. Miscellaneous Aluminum: ASTM B 221, Alloy 6063.

Plate and Sheet	ASTM B209	6061-T6	T651 Alloy
Structural Shapes	ASTM B308	6061-T6	Alloy
Extruded Shapes	ASTM B221	6061-T6	

Castings ASTM B108 214 Alloy

2.04 FASTENERS

A. Provide Type 316 stainless steel fasteners for all exterior and interior work unless otherwise shown or specified.

B. Bolting

1. Either

a) Bolts - ASTM A193 Grade B8

b) Nuts - ASTM A194 Grade M

2. Or

a) Bolts - ASTM 276 Type 316 Stainless Steel

b) Nuts - ASTM 276 Type 316 Stainless Steel

2.05 GALVANIZING

A. Galvanizing

1. Shapes ASTM A-123 2.0 OZ/SF

2. Hardware ASTM A-153 2.0 OZ/SF

2.06 STAINLESS STEEL METALS AND FABRICATIONS

A. STAINLESS SHAPES ASTM A276 TYPE 316

B. STAINLESS PLATE ASTM A240 TYPE 316

PART 3 EXECUTION

3.01 FABRICATION, GENERAL

A. Workmanship: Use materials of size and thickness indicated, or if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of work.

B. Aluminum fabrication shall be in conformance with the Aluminum Association, Inc. "Specifications for Aluminum Structures"

C. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flathead (countersunk) screws or bolts.

E. Provide for anchorage of type indicated, coordinated with supported structure. Fabricate and space anchoring devices to provide adequate support for intended use.

F. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

G. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

H. Surface Preparation: Prepare ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications, unless otherwise specified.

1. Exterior (SSPC Zone 1B): SSPC-SP6 "Commercial Blast Cleaning".

2. Interior (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning".

I. Provide miscellaneous steel framing and supports which are not a part of structural steel framework, as required to complete work.

3.02 FIELD MEASUREMENTS

A. Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and

fitting where taking field measurements before fabrication might delay work.

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.03 TOUCH-UP PAINTING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paints, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. All aluminum surfaces to come in contact with concrete or dissimilar metals shall be coated with two coats of aluminum pigmented bituminous paint.

END OF SECTION

SECTION 05520

HANDRAILS AND GUARD RAILS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. This Section includes providing handrails and guard rails as shown on the Drawings and includes miscellaneous handrails and guard rails not included in other metal systems in other sections of these specifications.

B. Height for stair rails, handrails, and guard rails shall conform to all applicable codes.

C. Handrails and guard rails used to extend existing facilities shall match the existing as closely as possible unless noted otherwise.

1.02 QUALITY ASSURANCE

A. Codes and Standards:

1. Florida Building Code, latest version.

2. ANSI A117.1.

3. OSHA Part 1920.23 and 1910.24.

4. Life Safety Code 101.

5. AWS "Structural Welding Code".

B. Qualification for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

C. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job process; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.

D. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for

shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.

1.03 SUBMITTALS

A. Submit Certificates of Compliance with specified requirements. Obtain shop drawings for fabrication and erection. After verifying details and dimensions provide three sets of final drawings and installation instructions to Engineer for use in observing installation and for Record Drawings.

B. All submittals for this Specification shall be in accordance with Section 01340 – Shop Drawings, Project Data and Samples.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aluminum Extrusions: ASTM B221; alloy 6061-T6, T6510; except alloy 6061-T6 for pipe; unless otherwise indicated.

B. Aluminum Castings: ASTM B108; alloy 214 unless otherwise indicated.

C. Aluminum Sheet or Plate: ASTM B209; alloy 6061-T6, unless otherwise indicated.

D. Finish: Clear anodized finish AA C22A41R1X, medium matte, nondirectional, minimum 0.7 mil clear anodized, clear lacquer coating, unless otherwise indicated.

E. Nonshrink, Nonferrous Grout: CE CRD C588.

2.02 FABRICATION

A. The Contractor shall provide a "manufacturer's system" using welded connections. System to include layout of joints that allow movement for thermal expansion/contraction.

B. Exposed work shall be formed true to line and level with accurate angles and surfaces and straight sharp edges.

C. Ease exposed edges to a radius of approximately 1/32-inch, unless otherwise shown.

D. Use bent-metal corners formed to the smallest radius possible without causing grain separation or otherwise impairing the work.

E. Welded Connections: Cope intersections of rails and posts, weld joints and grind smooth. Butt weld end-to-end joints of railings or use welding connectors, at fabricator's option.

F. Weld corners and seams continuously and in accordance with the recommendations of AWS. Grind exposed welds smooth and flush to match and blend with adjoining surfaces. Discoloration of finished surfaces will not be acceptable.

G. Form exposed connections with flush, smooth, hairline joints, using concealed fasteners wherever possible. Use exposed fasteners of the type shown, or if not shown, use Phillips flathead (countersunk) screws or bolts.

H. Provide anchorage of the type shown, coordinated with the supporting structure. Fabricate and space anchoring devices as shown and as required to provide adequate support.

I. Toe Boards: Fabricate toe boards to the dimensions and details shown. If not shown, use 1/4-inch thick x 4-inch plate secured to each post of railing.

J. Brackets, Flanges and Anchors: Provide brackets, flanges, and anchors for railing posts and for handrail supports. Furnish inserts and sleeves as required for anchorage masonry work.

K. Furnish cast metal brackets, flanges, and exposed anchors of the same material and finish as rail supports, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which handrails and guard rails are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Furnish setting drawings, diagrams, templates, instructions and directions for the installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.

3.03 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing handrails and guard rail items to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as required.

B. Use railing manufacturer's standard methods of installation when acceptable to the Engineer.

C. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation. Set the work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels.

D. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Grind joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surface of units which have been coated or finished after fabrication, and are intended for field connections. Adjust railings prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 6-feet on centers, unless otherwise shown. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

E. Anchor posts in concrete by means of pipe sleeves set and anchored into the concrete. Provide sleeves of galvanized, steel pipe, not less than 6-inches long and having an inside diameter not less than 1/2-inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve and of width and length not less than

1-inch greater than the outside diameter of the sleeve. After the posts have been inserted into the sleeves, fill the annular space between post and sleeve solid with nonshrink, nonferrous grout. Cover anchorage joint with a round metal flange finished to match post.

F. Anchor rail ends into concrete and masonry with round flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

G. Field Welding: Comply with AWS Code for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting the work.

H. Dissimilar Materials: Where dissimilar metals contact each other or there is a condition such as aluminum against concrete, they shall be protected from each other with a pressure sensitive tape, bitumastic coating or other protective method.

I. Toe Boards: Provide toe boards where shown and as required by code.

J. Toe boards shall be provided wherever people can pass or work beneath the open sides or wherever falling material could create a hazard to moving machinery or equipment.

END OF SECTION

SECTION 5531

ACCESS HATCHES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, equipment and incidentals required and install access hatches as shown on the Drawings and specified herein. Prefabricated access hatches and frames shall be sized as shown on the drawings and be included but are not limited to the following:

1. Reclaimed Water Return Pump Station for the North Pond.
2. Waste Backwash Pump Station for the Gravity Disk Filters.
3. Reject Pump Station Intake Manhole.

1.02 COORDINATION

A. The work in this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.03 SHOP DRAWINGS AND SAMPLES

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

B. Detailed drawings, as provided for in the Contract Documents, showing sizes of members, method of assembly, anchorage, and connection to other members shall be submitted to the Owner’s Representative for approval before fabrication.

C. Samples shall be submitted at the request of the Owner's Representative for concurrent review with Shop Drawings.

1.04 FIELD MEASUREMENTS

A. Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.

1.05 REFERENCED SPECIFICATIONS

A. Unless otherwise specified, materials shall conform to the following:

Structural Steel	ASTM A36
Welded & Seamless Steel Pipe	ASTM A53
Gray Iron Castings	ASTM A48,Class 30
Galvanizing, general	ASTM A123
Galvanizing, hardware	ASTM A153
Galvanizing, assemblies	ASTM A386
Aluminum(Extruded Shapes)	6061-T6(Alum. alloy)
Aluminum (Extruded Pipe)	6061-T6 (Alum. alloy)
Aluminum Bar Structural	6061-T6 (Alum. alloy)
Bolts and Nuts	ASTM,A307-316 SS
Fasteners	AISI, Type 316 SS
Steel Plate and Sheet Wire	AISI, Type 316 SS
Welding Rods for Steel	AWS Spec. for Arc Welding

1.06 LOAD REQUIREMENTS

A. For Access Hatches installed in the Reclaimed Water Return and Waste Backwash Pump Stations:

1. 300 pounds per square foot live loading.

B. For the Reject Pump Station Intake Manhole:

1. H2O Loading.

1.07 WARRANTY

A. Per General Conditions Article 9, the Contractor shall provide a 3 year warranty from substantial completion.

PART 2 PRODUCTS

2.01 ANCHORS, BOLTS AND FASTENING DEVICES

A. Anchors, bolts, etc., shall be furnished as

necessary for installation of the work of this Section.

B. Compound masonry anchors shall be of the type shown or required and shall be equal to Star Slug in compounded masonry anchors manufactured by Star Expansion Industries, equal by Phillips Drill Co., Rawlplug, or equal. Anchors shall be minimum "two unit" type.

C. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Stainless steel shall be attached to concrete or masonry by means of 316 stainless steel machine bolts, and iron or 316 stainless steel shall be attached with 316 stainless steel machine bolts unless otherwise specifically noted.

D. For structural purposes, unless otherwise noted, expansion bolts shall be Wej-it "Ankr-Tite", Phillips Drill Co. "Wedge Anchors", or Hilti "Kwik-Bolt". When length of bolt is not called for on the Drawings, the length of bolt provided shall be sufficient to place the wedge portion of the bolt a minimum of 1-inch behind the reinforcing steel within the concrete. Material shall be as noted on the Drawings. If not listed, all materials shall be 316 stainless steel.

2.02 ALUMINUM ITEMS

A. Prefabricated checker-plate aluminum floor hatches shall be designed for 300 pounds per square foot loading or for H2O loading as described in Paragraph 1.06, and manufactured by Bilco, Halliday, US Foundry or approved equal. Hatches with either dimension over 3 feet-6 inches shall be double leaf type unless otherwise shown on the drawings.

B. Aluminum Hatches. Hatches shall be flush aluminum pit access doors, Halliday Type W1S, or approved equal. Frames shall be 1/4" aluminum with continuous anchor flange. Cover shall be 1/4" aluminum diamond pattern plate

reinforced for a 300 pounds per square foot live load or H2O live load with 316 SS heavy duty hinges and hinge pins and 316 SS spring assists for ease of operation. The maximum allowable deflection shall be 1/150 of the span. The cover shall open to 90 degrees and lock automatically in the position with a 316 SS hold-open arm. A vinyl grip aluminum handle shall be provided to release the cover for closing. A 316SS slam lock and removable handle shall be provided. Also provide locking hasp. Hardware shall be 316 stainless steel. Factory finish shall be a mill finish with bituminous coating applied to exterior of the frame. Access covers shall carry a lifetime guarantee against defects in material and/or workmanship.

C. Checkerplate aluminum cover plates shall be fabricated to the details shown and installed at the locations shown.

D. Entrance Hatches: The pumping station wet wells shall be equipped with aluminum access covers of adequate size to permit easy removal and installation of submersible sewage pumps and equipment.

E. Structural aluminum channel door frames shall be provided as shown on the Drawings.

F. Miscellaneous aluminum shapes and plates shall be fabricated as shown. Angle frames for hatches shall be furnished complete with welded strap anchors attached. Furnish all miscellaneous aluminum shown, but not otherwise detailed.

2.03 STEEL ITEMS

A. Steel items shall be fabricated and installed in accordance with the Drawings and shall include: support brackets, splice plates, anchor bolts, and any other miscellaneous steel called for on the Drawings and not otherwise specified.

PART 3 EXECUTION

3.01 FABRICATION

A. All metal work for access hatches shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.

B. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connection to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.

C. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.

D. Welding of parts shall be in accordance with the Standard Code of Arc and Gas Welding in Building Construction of the AWS and shall only be done where shown, specified, or permitted by the Engineer. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting or discoloration.

F. All aluminum finish exposed surfaces, except as specified below, shall have manufacturer's standard mill finish. Aluminum handrails shall be given an anodic oxide treatment in accordance with the Aluminum Association Specification AA-C22-A41. A coating of methacrylate lacquer shall be applied to all aluminum shipment from

the factory.

3.02 INSTALLATION

A. Install all furnished items embedded in concrete or other masonry. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted. All dimensions shall be verified at the site before fabrication is started.

B. All steel surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

C. Where aluminum is embedded in concrete, apply a heavy coat of approved bitumastic troweling mastic in accordance with the manufacturer's instructions prior to installation.

D. Where aluminum contacts masonry or concrete, provide a 1/32-inch neoprene gasket between the aluminum and the concrete or masonry.

E. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer and provide a 1/32-inch neoprene gasket between the aluminum and the dissimilar metal.

F. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

END OF SECTION

SECTION 05532

ALUMINUM GRATING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of aluminum grating shall include all necessary fasteners and accessory items to make a complete system.

1.02 QUALITY ASSURANCE

A. Codes and Standards: Provide the aluminum grating to conform to the following codes and standards per current edition:

1. ASTM B 221: Specification for Aluminum Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

2. ANSI/NAAMM MBG 531: Metal Bar Grating Manual.

3. ASTM E-448: Test Method for Strength of Anchors in Concrete and Masonry Elements.

4. ASCE 7: Minimum Design Loads for Buildings and Other Structures.

5. AWS D1.2: Structural Welding Code – Aluminum.

1.03 SUBMITTALS

A. Submit manufacturer's specifications, load tables, dimensions, diagrams, anchor details and installation instructions in accordance with Section 01340 – Shop Drawings, Project Data and Samples.

B. On request, furnish reports of load versus deflection tests conducted on assembled grating panels. Such tests shall be certified by an independent, nationally recognized testing laboratory.

C. Shop Drawings: Submit shop drawings for the fabrication and erection of all assemblies of work which are not completely shown by the manufacturer's data sheets. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.

1. Include setting drawings and templates for location and installation of accessory items and anchorage devices.

1.04 JOB CONDITIONS

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, don't delay job progress; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.

B. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.05 WARRANTY/GUARANTEE

A. Manufacturer's Standard Warranty: The grating sections shall be free of defects in material and workmanship for one year from date of shipment. If the materials are defective, the manufacturer shall repair or replace them at no additional cost.

PART 2 PRODUCTS

2.01 ALUMINUM GRATING

A. The Aluminum Grating design shall be manufactured with alloy 6063-T6.

B. The bar grating size shall be as noted on the construction drawings.

C. Walking Surface Finish: The grating surface shall have a plain fluted pattern surface.

D. Color: The grating color shall be natural aluminum.

2.02 ACCESSORIES

A. Fastener: Provide stainless steel fasteners with hold down clips for sectional and frame attachment with stainless steel Allen wrench screw type by the manufacturer.

B. Frame: Provide where required extruded aluminum alloy 6063-T6 frame by the grating manufacturer. The frame finish shall match that of the specified grating.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that the grating installation will not disrupt other trades and verify that the substrate is clean and free of foreign matter. Correct all defects prior to installation.

3.02 INSTALLATION

A. General: Install the grating in accordance with the project drawings, specifications, approved shop drawings, and manufacturer’s installation standards.

B. Grating panels shall be fabricated to be square within manufacturer’s tolerances and free from warping and any defect that may affect serviceability and reliability.

C. Install the grating with a min. 1-1/2 inch bearing surface at the frame or support ends. The grating shall be fastened to the frame or support substrate using fasteners and clips supplied by the grating manufacturer. Fastening shall be consistent with the manufacturer’s instructions.

D. Tolerances between sections shall not exceed the dimensional spacing of the grating style type. Adjacent sections shall line up to form an uninterrupted straight line, where possible.

E. Grating sections shall be installed to be removable unless indicated otherwise.

F. Openings may be field cut by the installer where indicated to permit field installation of wiring, equipment, piping, etc. All rectangular cutouts shall be made to the next bearing section past the obstruction. The cutout clearance to obstruction from the edge of the grating shall be no larger than 2 inches. Cutouts may be done in the field (unless otherwise requested), however weld a rectangular band bar of the same material and height of the bearing bars along the edge of the cut out.

END OF SECTION

SECTION 05533

STAINLESS STEEL GRATING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of stainless steel grating shall include all necessary fasteners and accessory items to make a complete system.

1.02 QUALITY ASSURANCE

A. Codes and Standards: Provide the stainless steel grating to conform to the following codes and standards per current edition:

1. ASTM A-276: Standard specification for stainless and heat resisting steel bars and shapes.

2. ANSI/NAAMM MBG 531: Metal Bar Grating Manual.

3. ASTM E-448: Test Method for Strength of Anchors in Concrete and Masonry Elements.

4. ASCE 7: Minimum Design Loads for Buildings and Other Structures.

5. AWS: Structural Welding Code – Stainless Steel.

1.03 SUBMITTALS

A. Submit manufacturer's specifications, load tables, dimensions, diagrams, anchor details and installation instructions in accordance with Section 01340 – Shop Drawings, Project Data and Samples.

B. On request, furnish reports of load versus deflection tests conducted on assembled grating panels. Such tests shall be certified by an independent, nationally recognized testing laboratory.

C. Shop Drawings: Submit shop drawings for the fabrication and erection of all assemblies of work which are not completely shown by the manufacturer's data sheets. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.

1. Include setting drawings and templates for location and installation of accessory items and anchorage devices.

1.04 JOB CONDITIONS

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, don't delay job progress; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.

B. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.05 WARRANTY/GUARANTEE

A. Manufacturer's Standard Warranty: The grating sections shall be free of defects in material and workmanship for one year from date of shipment. If the materials are defective, the manufacturer shall repair or replace them at no additional cost.

PART 2 PRODUCTS

2.01 GRATING

A. The Stainless Steel Grating design shall be manufactured with 304 stainless steel in accordance with ASTM A-276.

B. The rectangular bearing bar grating size shall be 1-1/2 inches depth by 3/16-inch width with a clear span of 5.5 feet. The rectangular bar grating shall be spaced 1-3/16 inches apart with cross bars spaced 4-inches apart unless noted otherwise by the construction drawings.

C. The type of grating shall be welded or swage locked. The grating shall have a minimum uniform load capacity of 300 pounds per square foot and a minimum safe concentrated load capacity of 850 pounds per foot.

D. Stainless Steel grating shall have a commercial clean finish provided by the manufacturer consisting of abrasive blast and passivation.

2.02 ACCESSORIES

A. Fasteners: Provide stainless steel fasteners with hold down clips for sectional and frame attachment with stainless steel Allen wrench screw type by the manufacturer.

B. Frame: Provide 304 stainless steel frames for each 304 stainless steel grating unit fabricated by the grating manufacturer. The frame finish shall match that of the specified grating.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that the grating installation will not disrupt other trades and verify that the substrate is clean and free of foreign matter. Correct all defects prior to installation.

3.02 INSTALLATION

A. General: Install the grating in accordance with the project drawings, specifications, approved shop drawings, and manufacturer’s installation standards.

B. Grating panels shall be fabricated to be square within manufacturer’s tolerances and free from warping and any defect that may affect serviceability and reliability.

C. Install the grating with a min. 1-1/2 inch bearing surface at the frame or support ends. The grating shall be fastened to the frame or support substrate using fasteners and clips supplied by the grating manufacturer. Fastening shall be consistent with the manufacturer’s instructions.

D. Tolerances between sections shall not exceed the dimensional spacing of the grating style type. Adjacent sections shall line up to form an uninterrupted straight line, where possible.

E. Grating sections shall be installed to be removable unless indicated otherwise.

F. Openings may be field cut by the installer where indicated to permit field installation of wiring, equipment, piping, etc. All rectangular cutouts shall be made to the next bearing section past the obstruction. The cutout clearance to obstruction from the edge of the grating shall be no larger than 2 inches. Cutouts may be done in the field (unless otherwise requested), however weld a rectangular band bar of the same material and height of the bearing bars along the edge of the cut out.

END OF SECTION

SECTION 05540

3-STRAND CABLE GUARD RAIL

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. This Section includes providing 3-Strand Cable guard rails as shown on the Drawings.

B. Height for the 3-strand cable guard rails shall conform to all applicable codes.

1.02 QUALITY ASSURANCE

A. Codes and Standards:

1. AWS "Structural Welding Code".

B. Qualification for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

C. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job process; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.

D. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.

E. All the equipment specified under this Section shall be furnished by a single manufacturer (the 3-strand Cable Guardrail Equipment Manufacturer) fully experienced, reputable, and qualified in the manufacture of the equipment specified.

F. Available Manufacturers – Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work are limited to Gibraltar Cable Barriers, Burnet, Texas, or approved equal.

1.03 SUBMITTALS

A. Submit Certificates of Compliance with specified requirements. Obtain shop drawings for fabrication and erection. After verifying details and dimensions provide three sets of final drawings and installation instructions to the Owner's Representative for use in observing installation and for Record Drawings.

B. All submittals for this Specification shall be in accordance with Section 01340 – Shop Drawings, Project Data and Samples.

1.04 WARRANTY

A. Per General Conditions article 9, the Contractor shall provide a 3 year warranty from substantial completion.

PART 2 PRODUCTS

2.01 MATERIALS

A. **Posts.** The same type of posts shall be used in a given run, except as shown on the plans or as approved by the Owner's Representative.

B. **Steel Posts and Plates.** Steel posts, anchor plates, bearing plates, soil plates and plate washers shall be structural steel in accordance with AASHTO M 270, Grade 36, shall be of the dimensions and weights shown on the plans and shall be galvanized in accordance with AASHTO M 111. Bolts, nuts and washers shall be in accordance with the dimensions shown on the plans and shall be galvanized in accordance with AASHTO M 232, or may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Any dimensional defects and structural discontinuities will be cause for rejection. The material to be welded shall be preheated in accordance with good welding practice, and welds shall be full-section and sound throughout. All welds shall be mechanically cleaned before galvanizing. No punching, drilling, cutting or welding will be permitted after galvanizing.

C. **Three-Strand Guard Cable.**

1. **Cable and Connecting Hardware.** The cable and connecting hardware shall be in accordance with AASHTO M 30 and AASHTO M 269. The wire rope shall be Type 1, ¾-inch diameter, 3 by 7 construction with a Class A coating. The rope, with connecting hardware, shall develop the breaking strength of a 25,000-pound single cable. Connecting hardware shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized. If mechanically galvanized, the coating, thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Cast Steel components shall be in accordance with AASHTO M 103, Grade 70-40, Class 1. Malleable iron castings shall be in accordance with ASTM A 47. Compensating devices shall have a spring constant of 0.46 psi, plus or minus 0.06 pound per inch, and permit 6 inches of travel, plus or minus one inch. All threaded parts on compensating cable end assemblies shall be in accordance with ASTM F 568, Class 4.6, ¾-10 threads. Socket baskets shall be designed for use with the cable anchor wedge as shown on the plans. Guard cable anchor brackets shall be manufactured from an AASHTO M 270, Grade 250 steel plate, and zinc-coated in accordance with AASHTO M 111. Dimensional tolerances not shown on the plans shall be consistent with the proper functioning of the part, including the part's appearance and accepted manufacturing process.

2. **Cable Brackets.** Steel used in the fabrication of the bracket shall be in accordance with ASTM A 36. The bracket shall be galvanized after fabrication in accordance with AASHTO M 111. All fittings, including splices, shall be designed to use the wedge detail, and shall be of such section as to develop the full strength of the ¾-inch 25,000-pound round cable. Designs for a combination or single-unit compensating device and turnbuckle assembly shall be submitted for approval. Compensating devices shall have a spring rate of 0.46 ± 0.03 pound per inch, and shall permit 6 inches ± one inch of travel. All parts, except cable wedge, shall be hot-dip zinc coated in accordance with AASHTO M 232 or AASHTO M 298.

3. **Hook Bolts, Hex Bolts, Nuts and Washers.** Hook bolts, hex bolts and washers shall be in accordance with ASTM A 307. Cable hook nuts shall be 5/16-18 threads and in accordance with ASTM A 563. Hook bolts, as installed, shall develop an ultimate pull open strength of 450 to 1000 pounds applied in a direction normal to the axis of the post. Hooked anchor studs shall be in accordance with AASHTO M 314, except the threads and nominal diameter shall be ¾-10 and in accordance with ASTM F 568, Class 4.6. All items shall be galvanized in accordance with AASHTO M 232 or may be mechanically galvanized in accordance with AASHTO M 232, Class C.

4. **Certification.** The contractor shall furnish the manufacturer's certification for all material governed by this specification. Specifically, each certification shall indicate compliance with the requirements of each applicable section as set forth in Table 05540-1.

5. **Repair of Galvanizing.** Galvanized material shall be handled in a manner to avoid damage surface. No field punching, drilling, cutting or welding will be permitted after galvanizing. Any galvanized material on which the spelter coating has been damaged will be rejected or may be repaired with approval from the Owner's Representative.

TABLE 05540-1 Certification Requirements		
Item	**Galvanizing Standard**	**Steel Grade**
Steel Posts, Plates and Brackets	AASHTO M 111	AASHTO M 270, Grade 36
Three Strand Guard Cable		
- Cable	AASHTO M 30	AASHTO M 30 & AASHTO M 269
- Hardware	AASHTO M 232	AASHTO M 102/ ASTM A 220
- Cast Steel Components	AASHTO M 232	AASHTO M 103
- Malleable Iron Castings	AASHTO M 232	ASTM A 47
- Anchor Brackets	AASHTO M 111	AASHTO M 270
- Cable Brackets	AASHTO M 111	AASHTO M 270, Grade 36
- Hook and Hex Bolts	AASHTO M 232	ASTM A 307
- Hook Nuts	AASHTO M 232	ASTM A 563
- Hooked Anchor Studs	AASHTO M 232	AASHTO M 314

D. Reinforced Concrete
   1. Minimum 28-day compressive strength = 2,500 psi

E. Steel Reinforcing
   1. ASTM A615, Grade 60

F. Minimum Dimensions
   1. Steel Anchor Post – 8″x8″x3′-0″
   2. Anchor Post Columns – 4″ x 2″
   3. Terminal and Line Posts – 3¼″ x 2½″x4′0″ C-Section Post
      4″x3″x15″ Socket

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which guard rails are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Furnish setting drawings, diagrams, templates, instructions and directions for the installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.

3.03 CONSTRUCTION REQUIREMENTS

A. **Line Posts.** All posts shall be installed in steel sockets embedded in concrete foundations. All posts shall be aligned to a tolerance of ¼ inch for plumb and grade line.

B. Anchor Assemblies. The specified type of anchor assembly shall be constructed at each end of a run of guard cable. If intermediate end anchors are required, the cable assembly shall be overlapped. The location of all intermediate anchor assemblies shall be determined by the contractor and approved by the Owner’s Representative. The concrete anchor shall be cast in place with the centerline normal to the line of the guard cable. The concrete anchor below finished ground shall be formed. Anchors shall be constructed on firm, stable, undisturbed soil to the minimum dimensions shown on the plans. Anchor bolts and post sockets shall be firmly held in the proper position supported at the top by a template during concrete placement. Backfill shall be thoroughly compacted with mechanical tampers with care taken to prevent damage to the finished concrete. Backfill shall be brought up level with the finished grade line.

C. Cables. Cables shall be attached to the line posts, anchor posts, cable transition brackets and anchor brackets as shown on the plans. Where compensating devices or turnbuckles are required, the cables shall be attached to the end anchor with turnbuckles fully opened. Compensating devices and turnbuckles shall be installed such that no interference with the functions of any other part of the system occurs. Individual cables may be spliced with a device approved by the Owner’s Representative. Each cable shall be stretched taught by mechanical means to eliminate sag between the posts. The contractor may tighten cable hook bolts after final cable tensioning is complete to allow cable

slack to be adequately taken up. Prior to final acceptance, the cables shall be tensioned in accordance with the temperature and spring compression table shown on the Manufacturer’s plans, and all cable hook bolts tightened.

END OF SECTION

SECTION 09900

PAINTING AND COATINGS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work includes furnishing all plant, labor, materials and equipment required to complete the painting and coatings as indicated on the Drawings and in these specifications.

B. Surface preparation, paint and coatings materials, and their application shall be as recommended by the coating manufacturer and approved by the Engineer. The Contractor shall take all health and safety precautions necessary to prevent accidents during the storage, handling, application, and drying of any of the coatings described.

C. Paints and coatings used to furnish the surfaces of structures or vessels which come into contact with potable water shall meet the applicable requirements of the County Health Department and the State Department of Environmental Protection or other regulatory agencies having jurisdiction.

D. Related Work Specified Elsewhere:

1. Section 09902 - Pipe and Equipment Painting

1.02 QUALITY ASSURANCE

A. The Contractor is responsible for a satisfactory paint application which will adhere without peeling, flaking, blistering or discoloration. Before application of any painting materials, the Contractor shall submit a letter of Certification from the manufacturer of the materials selected for the application proposed.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are limited to the following:

1. Ameron - Corrosion Control Division

2. Carboline Company

3. Rust-Oleum Corporation

4. Tnemec Company, Inc.

5. Kerneos, Inc.

6. Raven Lining Systems

1.03 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

B. Data Sheets and Color Charts:

1. The full name of each product and descriptive literature shall be submitted along with a list of water and wastewater plants in Florida where the product has been used.

2. Within a minimum of 30 days prior to application of paints and coatings, the Contractor shall submit six sets of color charts and data sheets for selection by the Owner. Before work is commenced, the Contractor shall prepare samples as required until the color and textures are satisfactory to the Owner.

3. Resubmit samples as requested until required sheen, color and texture is achieved.

4. On 12-inch x 12-inch hardboard, provide two samples of each color and material, with texture to simulate finish conditions. On actual wood surfaces, provide two 4-inch x 8-inch samples for stained wood finish. On concrete Masonry, provide two 4-inch square samples of masonry for each type of finish and color, defining filler, prime and finish coats. On actual wall surfaces and other building components, duplicate painted finish of acceptable samples, as directed by the Engineer.

1.04 DELIVERY AND STORAGE

A. Deliver materials to job site in new, original, and unopened containers bearing manufacturer’s name, trade name, and label analysis. Store where directed in accordance with manufacturer’s instructions. All paint materials used on the job shall be kept in a single

place which shall be kept neat and clean. All oily rags, waste or debris shall be removed every night and all precautions taken to avoid the danger of fire.

B. Extra Stock: At the conclusion of the project, the Contractor shall provide the Owner with a minimum of one quart from each 50 gallons or fraction thereof for each paint system used on the project. The paint or coating container shall indicate the applicable paint system as indicated in these specifications.

1.05 JOB CONDITIONS

A. Painting or coating and finishing of interior and exterior items and surfaces, unless otherwise indicated:

1. Paint all new construction and portions of existing facilities disturbed by new construction.

2. Paint all exposed surfaces, except as otherwise indicated, whether or not colors are designated. If not designated colors will be selected by the Owner’s Representative from standard colors available for the coatings required.

3. Includes field painting of bare and covered pipes and ducts (including color coding), and hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work.

4. Painting shall be done at such times as the Contractor and Owner’s Representative may agree upon in order that dust-free and neat work be obtained. Painting shall be done strictly in accordance with the manufacturer’s instructions and shall be performed in a manner satisfactory to the Owner’s Representative.

5. ”Shop” painting as referred to defines the paint coat which shall be applied in the shop or plant immediately after manufacture, fabrication or assembly and prior to shipment to the site of installation. “Field” painting defines the paint coats to be applied at the project site where the structure or equipment is completed, erected, or installed in place as specified.

B. Materials and Application:

1. Obtain painting materials from one manufacturer. Painting materials not obtainable from the prime manufacturer shall be obtained from a second source recommended by the prime manufacturer.

2. There shall be a perceptible difference in shades of successive coats of paint so that the application of successive coats of paint can be properly and uniformly spread and inspected. Pipes, sheet metal ducts and other metal items which are to be installed in inaccessible locations shall be painted prior to installation.

3. Each coat shall be allowed to dry for the period of time recommended by the manufacturer before the next coat is applied.

C. Equipment, Machinery, and Shop Fabricated Items:

1. Pumps, motors, machinery, equipment and other manufactured items shall have surfaces prepared, primed and finish-coated in accordance with the standard practice of the manufacturer. Finish coat colors shall be as approved by the Engineer.

2. Shop-fabricated items and components for field assembly shall have surfaces prepared and shop-primed. Finish coat colors shall be as approved by the Owner's Representative. Items for submerged service shall be field sandblasted and primed per Paint System B-3.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS - ALL SYSTEMS

A. The film thickness designated and/or the number of coats to be applied shall not be decreased and shall be increased where required to meet other manufacturer's recommendations.

B. There shall not be a change from the generic type of coating specified.

C. Manufacturer's recommendations as to which finish coat should be used with a particular primer shall be observed. In all cases, the prime coat and finish coat

shall be from the same manufacturer. All paint shall be mildew resistant.

D. Tnemec products are given as examples for a majority of painting and coating systems identified in the following paragraphs. The products of other manufacturer's (listed in Paragraph 1.02.B.) may be used as long as they are of the same quality and approved by the Owner's Representative.

2.02 GROUP A - CONCRETE AND MASONRY

A. System A-1. For use on above grade interior walls and ceilings and architectural surfaces not subject to high moisture, corrosion, splashing or fumes.

1. Surface Preparation: Level protrusions and remove mortar splatter from all surfaces. Allow new concrete to cure 28 days.

2. First Coat:

a) Concrete and dense block - Acrylic latex coating, matte finish, 2-3 mils of Tnemec 6 Tneme - Cryl, or Equal.

b) Lightweight or porous concrete block surfaces - two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat:

a) Concrete and dense block - Acrylic latex coating, semi-gloss type, minimum 2 mils dry thickness of Tnemec 1029 Enduratone, or Equal.

b) Lightweight or porous concrete block surfaces - acrylic latex coating, matte finish, 2-3 mils DFT, Tnemec 6 Tneme - Cryl, or Equal.

4. Third Coat:

a) Concrete and dense block - None.

b) Lightweight or porous concrete block surfaces - acrylic latex coating, semi-gloss type, 2-3 mils DFT, Tnemec 1029 Enduratone SG, or Equal.

B. System A-2. For use on above and below grade - interior walls, inside surfaces of tanks, ceilings, and non-traffic slabs, and subject to high moisture, corrosion, splashing or fumes. Use for immersion and non-immersion exposures.

1. Surface Preparation:

a) Concrete - Brush-off blast, to remove laitance, fines, curing compounds, form release oils, other contaminants, open up bugholes, and establish a surface profile equal to ICRI CSP 5. Re-surface concrete and fill voids and bugholes using Tnemec Series 218 MortarClad, applied @ 1/16”.

b) Concrete Block Surfaces - Clean and dry, level protrusions and remove mortar splatter from all surfaces.

2. First Coat:

a) Concrete - Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

b) Concrete Block Surfaces - Two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat:

a) Concrete- Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

b) Concrete Block- Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

4. Third Coat:

a) Concrete- NA

b) Concrete Block- Two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

C. System A-3. For use on exterior walls above grade to a point six inches below finish grade.

1. Surface Preparation. Fill voids with grout; remove loose protrusions and mortar splatter. Allow new concrete and stucco to cure 28 days.

2. First Coat:

   a) Concrete & Stucco: Acrylic latex coating, matte finish, 2-3 mils dry thickness of Tnemec 6 Tneme - Cryl, or Equal.

   b) Concrete Block: Two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat:

   a) Concrete and Stucco: Acrylic latex coating, semi-gloss type, 2-3 mils DFT of Tnemec 1029 Enduratone - or Equal.

   b) Concrete Block: Acrylic latex coating, matte finish, 2-3 mils DFT - Tnemec 6 Tneme - Cryl, or Equal.

4. Third Coat:

   a) Concrete: None

   b) Concrete Block & Stucco: Acrylic latex coating, semi-gloss type, 2-3 mils DFT-Tnemec 1029 Enduratone or Equal.

D. System A-4: For use on exterior walls below a point six inches below finish grade.

1. Surface Preparation: Brush-off blast.

2. First Coat: Asphalt base high build coal tar epoxy foundation coating, 8-10 mils DFT Tnemec 46H-413 hi-Build Tneme - Tar, or Equal.

3. Second Coat: Asphalt base high build coal tar epoxy foundation coating applied at right angles to First Coat, 8-10 mils DFT Tnemec 46H-413 hi-Build Tneme - Tar, or Equal.

E. System A-5: For use on interior concrete block walls.

1. Surface Preparation: Clean and dry, level protrusions and remove mortar splatter from all surfaces.

2. First Coat: Two component, inorganic hybrid water-based epoxy, 80-110 S.F./Gal - Tnemec Surface Coat 54WB, or Equal.

3. Second Coat: High performance acrylic epoxy, 4-6 mils DFT - Tnemec Series 113 H.B. Tneme-Tufcoat, or Equal.

2.03 GROUP B - STRUCTURAL STEEL; CONCRETE AND STEEL TANKS; EQUIPMENT AND PIPING

A. System B-1: For use on exposed structural and miscellaneous steel, piping, equipment, and tanks, both interior and exterior - not exposed to corrosion, splash, fumes, or immersion conditions.

1. Surface Preparation: Commercial blastclean per SSPC SP-6.

2. First Coat: One coat of Modified Aromatic Polyurethane Primer: Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT.

3. Second Coat: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

4. Third Coat:

a) Interior: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils DFT - Tnemec N69 HB Epoxoline II, or Equal

b) Exterior: One coat of semi-gloss acrylic polyurethane, 2.0-4.0 mils DFT-Tnemec Series 73 Endurashield, or Equal.

B. System B-2: For use on bituminous coated cast iron, ductile iron or steel pipe.

1. Surface Preparation: Hand or power tool clean, scarify or wire brush per SSPC SP-2 and SP-3.

2. First Coat: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 4-6 mils

DFT - Tnemec N69 HB Epoxoline II, or Equal. If the bituminous coating “bleeds through” after application of the first coat, allow the bleed through to dry prior to application of the second coat.

3. Second Coat: Same as first coat.

4. Third Coat (exterior exposure only): One coat of semi-gloss acrylic polyurethane finish, 2-3 mils DFT - Tnemec 73 Endura - Shield, or Equal.

C. System B-3: For use on interior walls of steel tanks, piping and equipment, submerged or non-submerged, exposed to spray, splash or corrosive atmosphere, excluding chains and sprockets and similar items. This system shall be used for all materials submerged or in contact with wastewater.

1. Surface Preparation. FIELD sandblast to a near white metal blast cleaning according to SSPC-SP10.

2. First Coat: One coat of Modified Aromatic Polyurethane Primer: Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT.

3. Second Coat: One coat of Hydrophobic Aromatic Polyurethane, Tnemec Series 446 Perma-Shield MCU, 6.0-8.0 mils DFT.

4. Third Coat: Same as second coat

D. System B-4: For use on structural steel, tanks, equipment and piping subject to severe abrasion, corrosive atmosphere, splash or spray, not in contact with wastewater or where a color finish is desired.

1. Surface Preparation: Submerged surfaces, near white metal blast according to SSPC-SP 10. Non-submerged surfaces, commercial blast according to SSPC-SP 6.

2. First Coat: One coat of Modified Aromatic Polyurethane Primer: Tnemec Series 1 Omnithane, 2.5-3.5 mils DFT.

3. Second Coat: One coat of Hydrophobic Aromatic Polyurethane, Tnemec Series 446 Perma-Shield MCU, 6.0-8.0 mils DFT.

4. Third Coat:

a) Interior - Same as second coat.
b) Exterior Exposure - One coat of semi-gloss polyurethane, 2-4 mils DFT - Tnemec 73 Endura - Shield, or Equal.

E. System B-5: For use on hollow metal (steel) doors and frames, steel embedments, and steel lintels:

1. Surface Preparation: Pre-primed with alkyd primer.

2. First Coat (touch-up only): Universal alkyd primer, 2-4 mils DFT, Tnemec 37H Chem-Prime HS, or Equal.

3. Second Coat: One coat of high-gloss HDP acrylic polymer, Tnemec Series 1028, 2.0-3.0 mils DFT.

4. Third Coat: Same as second coat.

2.04 GROUP C - GALVANIZED AND NON-FERROUS METALS

A. System C-1: For use on interior corrosive areas, submerged or non-submerged surfaces, non-potable water applications, galvanized steel and aluminum, including ductwork.

1. Surface Preparation: Solvent cleaning followed by brush-off blast to provide a 1 to 2 mil profile suitable for mechanical adhesion per SSPC-SP1.

2. First Coat: One coat of two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

3. Second Coat: Same as first coat.

B. System C-2: For use on interior dry galvanized steel and aluminum, including ductwork.

1. Surface Preparation: Solvent clean per SSPC-SP1.

2. First Coat: One coat of Two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

3. Second Coat: Same as first coat.

C. System C-3: For use 0n exterior areas, non-immersion, subject to occasional corrosive spray or

fumes, galvanized steel and aluminum materials, including ductwork.

1. Surface Preparation: Solvent cleaning followed by brush-off blast to provide a 1 to 2 mil profile suitable for mechanical adhesion per SSPC-SP7.

2. First Coat: One coat of Two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

3. Second Coat: One coat of polyurethane finish, 2.5-3.5 mils DFT -Tnemec 73 Endura - Shield, or Equal.

2.05 GROUP D – Gypsum Board

A. System D-1. For use on interior surfaces not exposed to moisture or corrosive conditions.

1. First Coat: One coat of Tnemec Series 6, 2-3 mils DFT, or Equal.

2. Second Coat: Semi-Gloss Finish: One coat of Tnemec Series 1029, 2-3 mils DFT, or Equal.

B. System D-2: For use on interior surfaces exposed to moisture, abrasion or mild chemicals.

1. First Coat: Tnemec Series 151, 250-350 SF/gal, or Equal.

2. Second Coat: Tnemec Series 113 H.B. Tneme-Tufcoat @ 4.0-6.0 mils DFT. One (1) coat is spray applied. Two (2) coats if applied by roller or brush.

2.06 GROUP E - WOOD

A. System E-1. For use on interior surfaces not exposed to moisture or corrosive conditions.

1. Surface Preparation: Sand smooth, seal knots with white shellac (fill holes with vinyl putty after prime).

2. First Coat: One coat of white pigmented, non penetrating alkyd-based primer, 2-3 mils DFT - Tnemec 10, or Equal.

3. Second Coat: One coat of matte finished acrylic coating, 2-3 mils DFT - Tnemec 6 Tneme - Cryl, or Equal.

4. Third Coat: One coat of semi-gloss acrylic, 2-3 mils DFT, Tnemec 1029 Enduratone SG, or Equal.

B. System E-2: For use on interior surfaces exposed to moisture or corrosive conditions, exterior wood, and exterior wood surfaces.

1. Surface Preparation: Sand smooth, seal knots with white shellac (fill holes with vinyl putty after prime).

2. First Coat: One coat of Two-component, polyamidoamine cured epoxy, semi-gloss 2.5-3.5 mils DFT - Tnemec N69 HB Epoxoline II, or Equal.

3. Second Coat: Same as first coat.

C. System E-3: For use on interior wood paneling and trim.

1. Surface Preparation: Sand smooth, seal knots with white shellac (fill holes with vinyl putty after prime).

2. First Coat: One coat of white pigmented non-penetrating alkyd based primer, 2-3 mils DFT, Tnemec 10, or Equal.

3. Second Coat: One coat of semi-gloss acrylic finish, 1.5-2.5 mils DFT, Tnemec 1029 Enduratone, or Equal.

4. Third Coat: Same as second coat.

2.07 GROUP L - WALLS OF CONCRETE PROCESS TANKS

A. System L-1. For use on exterior of concrete tank walls below a point 6 inches below finish grade.

1. Surface Preparation: Fill voids with grout; remove loose protrusions and mortar splatter, brush-off blast.

2. One coat of high build coal tar epoxy, 14-20 mils DFT, Tnemec 46 H-413 Hi-Build Tneme-Tar, or Equal.

B. System L-2. For use on the interior of open top concrete tanks submerged or non-submerged, exposed to

spray, splash or corrosive atmosphere and/or in contact with wastewater.

1. Surface Preparation. Brush-off blast, to remove laitance, fines, curing compounds, form release oils, other contaminants, open up bugholes, and establish a surface profile equal to ICRI CSP 5. Re-surface concrete and fill voids and bugholes using Tnemec Series 218 MortarClad, applied @ 1/16”.

2. First Coat: One coat of Hydrophobic Aromatic Polyurethane, Tnemec Series 446 Perma-Shield MCU, 6.0-8.0 mils DFT.

3. Second Coat: Same as first coat.

C. System L-3: For use on interior walls and ceiling of concrete wet wells, submerged or non-submerged, exposed to spray, splash or corrosive atmosphere, and in contact with wastewater.

1. Surface Preparation. Brush-off blast, to remove laitance, fines, curing compounds, form release oils, other contaminants, open up bugholes, and establish a surface profile equal to ICRI CSP 5. Re-surface concrete and fill voids and bugholes using Tnemec Series 218 MortarClad, applied @ 1/16”.

2. First Coat: One coat of amine cured epoxy 100% VOC free/100% solids Raven 405, minimum 80 mils DFT and as recommended by Coating manufacturer, or Equal. Application shall be by manufacturer’s qualified applicator (letter of qualification from the manufacturer shall be required).

3. Testing:
   (a) Coating shall be spark tested.
   (b) Wet film thickness gauge per ASTM D4414
   (c) Pull-off adhesive strength of coatings per ASTM D7234.

D. System L-4: For use on exterior walls and domes of reject storage tanks.

1. Surface Preparation: Per manufacturer’s recommendations.

2. First Coat: One coat of modified waterborne acrylic from 4.0-6.0 mils DFT, Tnemec Enviro-Crete Series 156 or equal

3. Second Coat: One coat of modified waterborne acrylic from 4.0-6.0 mils DFT, Tnemec Enviro-Crete Series 156 or equal

2.07 GROUP M - SPECIAL COATINGS

A. System M-1. For use as barrier between dissimilar materials and metals.

1. Prime: None

2. Finish: One component coal tar solution, Tnemec Series 46-465, 8.0-10.0 mils DFT

B. System M-2. For sealing concrete floors where concrete is shown as natural in the Finish Schedules and on all exposed concrete floors where no finish has been shown.

1. Surface Preparation: Mechanically abrade floor to achieve a profile equal to ICRI CSP 2-CSP 3.

2. First Coat: One coat of clear epoxy floor sealer, 8-10 mils DFT, Tnemec 201 Epoxoprime, or Equal.

C. System M-3. For coating of PVC piping interior or exterior.

1. Surface Preparation: SSPC SP1 first then scarify surface.

2. Prime: Epoxy equal to Tnemec Series 66 at 2.0 to 3.0 mil DFT.

3. Finish: Epoxy equal to Tnemec Series 73 at 2.0 to 3.0 mil DFT.

2.08 FINISH COAT OVER EXISTING FINISH

A. The required painting shall consist of one coat of the system “Finish Coat” to provide continuity of texture and color over previously painted surfaces.

2.09 THINNING

A. Where thinning is necessary, only the products for the particular purpose and by the manufacturer furnishing the paint shall be allowed. All thinning shall be done strictly in accordance with the manufacturer’s

instructions and with the full knowledge and approval of the Engineer.

PART 3 EXECUTION

3.01 SHOP PAINTING

A. All ferrous and non-ferrous surfaces shall be solvent cleaned before priming. Primer shall be applied in the shop to protect surfaces from rust during shipment and storage.

B. Apply two coats of paint to surfaces which are inaccessible after assembly or erection.

3.02 FIELD PREPARATION

A. All surfaces to be painted shall be prepared in a workmanlike manner with the objective of obtaining a smooth, clean and dry surface. No painting shall be done before the prepared surfaces are approved by the Engineer.

B. Surface preparation for miscellaneous surfaces to be painted, not specifically covered in these specifications, shall be as recommended by the manufacturer of the paint selected for use and as approved by the Engineer.

C. Perform preparation and cleaning procedures in strict accordance with coating manufacturer’s instructions for each substrate condition.

D. Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not to be finish-painted, or provide surface-applied protection. Reinstall removed items after painting is completed. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes to masonry walls unless moisture content of surfaces are below 12 percent.

3.03 APPLICATION

A. Mix, prepare, and store painting and finishing materials in accordance with manufacturer’s directions.

B. Apply painting and finishing materials in accordance with the manufacturer’s directions. Use applicators

and techniques best suited for the material and surfaces to which applied.

C. Workmanship for applying paint shall be of professional quality. The painter shall apply each coat at the rate recommended by the manufacturer smoothly without runs, sags, or holidays. If the material has thickened or must be diluted for use with a spray gun, the coating shall be built up to the same thickness as achieved with undiluted materials. In other words, one gallon of paint as originally furnished by the manufacturer shall not cover a great square foot area when applied by spray gun than when applied by brush. Deficiencies in film thickness shall be corrected by the application of additional coat or coats of paint. On masonry, application rates will vary according to the surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint. Before succeeding coats are applied to a surface, the preceding coat shall have been approved by the Owner's Representative.

D. Drying time shall be construed to mean "under normal conditions". Where conditions are other than normal because of the weather or because painting must be done in confined spaces, longer drying times will be necessary. Additional coats of paint shall not be applied, nor shall units be placed in service, until paints are thoroughly dry.

TABLE 09900-1
PAINTING SCHEDULE

A. Lake Filters :

1. Structural steel and decking – System B-4.
2. Ductile iron pipe, valves, fittings, equipment, motors and supports - System B-4.
3. Galvanized and non-ferrous metals – System C-3.
4. PVC pipe and conduit– System M-3.
5. Concrete Support Slab for Disk Filters – System M-2
6. Stainless Steel Equipment, Pipe, Valves, Supports, Etc., - None

B. Reclaimed Water Return Pump Station:

1. Ductile iron pipe, valves, fittings and supports - System B-4.
2. Galvanized and non-ferrous metals – System C-3.
3. Exterior Concrete walls of wet well - System A-4 (one coat, 8-10 mils).
4. Interior Concrete walls, floor and ceiling of wet well - System A-4 (2 coats, 8-10 mils each).
5. PVC pipe and conduit– System M-3.
6. Top of Concrete Wetwell Cover and Concrete Slab – System M-2
7. Stainless Steel Items – None

C. Disk Filter Waste Backwash Pump Station

1. Ductile iron pipe, valves, fittings and supports – System B-4.
2. Galvanized and non-ferrous metals – System C-3.
3. Exterior Concrete Walls of Wetwell – System A-4 (One Coat, 8-10 mils).
4. Interior Concrete Walls, Floor and Ceiling of Wetwell – System A-4 (2 coats, 8-10 mils each).
5. PVC Pipe and Conduit – System M-3.
6. Top of Concrete Wetwell Cover and Concrete Slab – System M-2.
7. Stainless Steel Items – None

D. ELECTRICAL BUILDING

1. Interior masonry walls – System A-1.
2. Interior gypsum wall board – System D-1.
3. Exterior masonry/stucco walls, above grade – System A-3.
4. Exterior masonry and concrete walls, below grade – System A-4.

5. Misc. internal steel – System B-1.
6. Fuel piping – System B-4.
7. Galvanized conduit – System C-2.
8. Interior concrete slab and housekeeping pads – System M-2.

E. NORTH POND OUTLET STRUCTURE

1. Exterior concrete and masonry walls above grade to 6-inches below finish grade – System A-3.
2. Exterior concrete walls below finish grade – System A-4.
3. Galvanized and non-ferrous metals – System C-3.
4. PVC pipe and conduit – System M-3.
5. Miscellaneous above grade steel, cast iron and ductile iron items – System B-4.
6. Stainless steel items – None
7. Aluminum items – None

F. EFFLUENT FLOW METER AND CONTROL VALVE ASSEMBLY

1. Ductile iron pipe, valves, meter, fittings and supports – System B-4.
2. Concrete support pads – System M-2.
3. Galvanized and non-ferrous metals - Systems M-3.
4. PVC pipe and conduit – System M-3.
5. Stainless steel items – None
6. Aluminum items – None

G. REJECT WATER CONNECTIONS AT HEADWORKS AND FILTER NO. 7, WASTE BACKWASH WATER CONNECTION AT FILTER NO. 7

1. Exterior concrete and masonry walls above grade – System A-3.
2. Ductile iron pipe, valves, fittings and support – System B-4.
3. Galvanized and non-ferrous metals – System C-3.
4. PVC pipe and conduit – System M-3.
5. Stainless steel items – none
6. Aluminum items - None

Note:

1. Cast iron, ductile iron or steel pipe that will be exposed to view and has been inadvertently coated with a bituminous system shall receive System B-2.

END OF SECTION

SECTION 09902

PIPE AND EQUIPMENT PAINTING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. This Section includes pipe painting and identification as required for this project.

1.02 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

PART 2 PRODUCTS

2.01 PAINTING AND IDENTIFICATION

A. Exposed piping (except stainless steel) shall be painted. Metal pipe shall be painted B-3 or B-4 depending on location. Seal coats shall be used over bitumen coated surfaces as applicable utilizing System B-2. Plastic pipe shall be painted in accordance with pipe manufacturer's recommendations utilizing System M-3.

B. General Notes and Guidelines:

1. All color numbers and names herein refer to Tnemec master color card. Colors of specified equal manufacturers may be substituted with approval of the Owner’s Representative.

2. Pipe lines, equipment, or other items which are not listed here shall be assigned a color by the Engineer and shall be treated as an integral part of the Contract.

3. When color coding is specified or directed by the Engineer, it shall consist of color code painting and identification of all exposed conduits, through lines and pipelines for the transport of gases, liquids, or semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors and any operating accessories which are integral to a whole functional mechanical pipe and electrical conduit systems.

4. Description on titles (Abbreviated Code on Pipe/Equipment), to be lettered on pipes or equipment will be black or white to contrast with color of pipes and equipment, and shall be stencil applied, as approved by the Owner's Representative.

5. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange 04SF.

6. All safety equipment shall be painted in accordance with OSHA standards.

7. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color.

8. All pipe hangers and pipe support floor standards shall be painted.

9. All conduit shall be painted to match its background surface.

10. Building surface colors shall be painted as scheduled in the Finish Schedule or as selected by the Owner's Representative.

11. Doors and frames shall be painted as scheduled in the Finish Schedule or as selected by the Owner's Representative.

12. Wood casework, frames, doors, etc. shall be finished with urethane as specified except as specifically noted otherwise.

2.02 PAINT COLOR CODE SCHEDULE

A. In situations where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be painted on one of the pipes at approximately 30-inch intervals. The name of the liquid or gas should also be painted (stenciled) on the pipe in a contrasting color. In some cases, it may be advantageous to paint arrows indicating the direction of flow.

Description of Title to be Lettered on Pipes and Equipment	Color of Title Letters	Pipe and Equipment Color	
		Color Name	Color Number
EQUIPMENT			
Conveyors, Sludge Hoppers, & Related Equip.	White	Safety Orange	04SF
Bar Screens	White	Safety Orange	04SF
Grit Collector Housing and Screw Conveyors	White	Safety Orange	04SF
Sump Pumps	White	Light Gray	A0385
Bridge Cranes, Monorails and Track	White	Safety Orange	04SF
Blowers	Black	Cypress Green	G0383
Sluice Gate Operators	White	Safety Orange	04SF
Scum Pumps	White	April Green	J8187
Pneumatic Ejectors	White	April Green	J8187
Air Compressors	White	Palm Green	G3102
Waste Sludge Pumps	White	Tan Bark	J6512
Air Filter Housings	White	Cypress Green	G0383
Sodium Hypochlorite Pumps	Black	Safety Yellow	02SF
Effluent Reuse Pumps	White	Pantone Purple	522-C
Filter and Effluent Sample Pumps	White	Aquamarine	G0427
Flash Mixers	White	Safety Orange	04SF
Flocculator Drives	White	Safety Orange	04SF
Clarifier Bridges and Pumps	White	Safety Orange	04SF
Odor Control System and Blowers	Black	Egg Shell	J6963
Alum Feed System	Black	Safety Orange	04SF
Polymer Feed System	Black	Oriental Yellow	D0852

Description of Title to be Lettered on Pipes and Equipment	Color of Title Letters	Pipe and Equipment Color	
		Color Name	Color Number
Polymer Tanks and Mixers	Black	Oriental Yellow	D0852
Polymer Pumps	Black	Oriental Yellow	D0852
Grit Screw Conveyor	White	Safety Orange	04SF
Sludge Pumps	White	Antique Brown	L9398
Conduit	White	Cypress Green	G0383
Conduit Trays	White	Cypress Green	G0383
Fans	White	Egg Shell	J6963
PIPES			
Raw Wastewater Pipe	White	Light Gray	A0385
Stainless Steel Air Pipe and Appurtenances	Black	Silver	Match S. Steel
Scum Pipe	White	April Green	J8187
Waste Sludge Pipe	White	Tan Bark	J6512
Sump Pump Pipe	White	Light Gray	A0385
Chlorine Pipe and Header	Black	Safety Yellow	02SF
Effluent Reuse Pipe	White	Pantone Purple	522-C
Chlorine Sample Pipe	Black	Safety Yellow	02SF
Polymer Pipe	Black	Oriental Yellow	D0852
Thickened Waste Sludge Pipe	White	Antique Brown	L9398
Cold Water	Black	Azure	J8162
Hot Water	Black	Azure	J8162
Soil Pipes	White	Light Gray	A0385
Fuel Pipe	White	Safety Red	06SF
Waste and Vent Pipes (Interior)	White	Match Background	
Waste Backwash from Disk Filters (BWW)	White	Tan Bark	J6512
Sodium Hypochlorite (NaOCL)	Black	Safety Yellow	02SF
Reclaimed Water Return (RCWR)	White	Pantone Purple	522-C

Reclaimed Water	White	Pantone	522-C
Recirculation (RECIRC)		Purple	
Reject (REJ)	White	Light Gray	A0385

2.03 PAINTING OF EXISTING STRUCTURES, PIPING, VALVING AND EQUIPMENT

A. Touch up existing structures and equipment where finish has been damaged by new construction.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 11001

EQUIPMENT – BASIC REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Provisions: Requirements specified in Division 1 form a part of this Section.

B. Work Included in this Section. The Contractor shall provide all the required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment for furnishing, installation, adjustment, and full test loading of all the mechanical work shown on the Contract Drawings and included in these Specifications.

C. Unless otherwise specified, the work of this division is also subject to the requirements of all other divisions of these specifications including, but not limited to: Divisions 9, 13, 15 and 16. Unless otherwise specified, all other sections of this division are subject to the requirements of this section.

1.02 QUALITY ASSURANCE

A. Incorporated Documents: Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of these Specifications where cited below. In every situation, the latest specifications, standards, tests, etc., shall apply unless otherwise noted.

B. Variances: In instances where two codes are at variance, the more restrictive requirements shall apply.

C. Contractor's Expense: The Contractor shall obtain and pay for the required bonds, insurance, licenses, permits, and inspections (unless otherwise specified), and pay all taxes, fees and utility charges that shall be required for the construction work.

D. Extra Work: Work that is not included in the Contract Documents shall not be performed, except when approved in writing by the Owner.

E. Standard of Quality: Items of equipment are specified herein by the name of a manufacturer for the purpose of establishing a standard of quality and acceptable experience. Alternate equipment will be given consideration, per Section 01600 – Material and Equipment.

F. Data: Unless otherwise specified, all equipment furnished shall have a data plate fabricated of 316 stainless steel with a minimum thickness of 1/16 inch and embossed or preprinted lettering, and fastened to the frame with corrosion-resisting pins. Nameplates shall have stamped on them the manufacturer, serial number, model number, type, operating and performance data, and other pertinent data. Letters and numerals shall not be smaller than 3/16 inch high.

G. Taggings: Where the size of the equipment prevents the fastening of data plates, name tags shall be provided and attached to the equipment and device item to identify it. The name tags shall have a rectangular configuration with square corners and shall be approximately 1-1/2 inches by 3 inches in size. They shall be made from brass or stainless steel sheet metal and have a minimum thickness of 0.032-inch. Letters and numerals shall be engraved or etched in the name tags by a professional engraver and shall not be smaller than 3/16 inch high in size. The name and number for each item of equipment, as designated on the Contract Drawings, shall appear on the name tag for the item. Valve tag information shall conform to Section 15100 – Valves and Appurtenances. A 3/16-inch diameter hole shall be provided in the upper left-hand corner of each name tag and shall be used to attach the name tags to the equipment and device items with 1/8-inch stainless steel cable.

1.03 DRAWINGS

A. Project Drawings: The Drawings are diagrammatic and show the general layout of the complete construction work.

1. Locations of equipment, inserts, anchors, motors, panels, conduits, stub-ups, fittings, fixtures, air, water, power and process inlets, unless specifically dimensioned on the Contract Drawings, shall be determined to suit field conditions encountered, and the Contractor shall be responsible for ensuring clearance between pipes,

equipment, and similar appurtenances, without extra cost to the Owner.

2. The Contractor shall review the Contract Drawings and Specifications of other trades and shall include the mechanical work shown thereon that will be required for the installations.

3. Should there be a need to deviate from the Contract Drawings and Specifications, the Contractor shall submit written details and reasons for all changes to the Engineer for approval before making such changes. All extra costs to make the changes will be borne by the Contractor.

4. In the event of varying interpretations of the Contract Documents, the Engineer's interpretation shall govern.

B. Shop Drawings

1. Prior to fabrication, the Contractor shall obtain, from the manufacturer, shop drawings for all equipment. Shop drawings shall include fabrication, assembly, unit support drawings, installation drawings, and wiring diagrams together with detailed specifications and data covering materials used, power drive assembly, parts, devices, and other accessories forming a part of the equipment to be furnished.

2. The Contractor shall submit Certified performance or Certified test curves, as specified for all pumps furnished under this Contract. The Contractor shall notify the Engineer three weeks prior to all testing should the Engineer elect to witness the tests.

3. Submit shop drawings and material lists for approval as specified in applicable Sections and in conformance with the requirements of Section 01340 – Shop Drawings, Project Data and Samples.

1.04 ADAPTATION OF EQUIPMENT

A. Should any alternate equipment selected require any revision to the structure, piping, electrical, or other work shown on the Contract Drawings, the Contractor shall include the cost of such revisions in his bid for the equipment and no extra payment shall be made for

such revision. All such revisions shall be subject to the approval of the Engineer.

1.05 UTILITY SERVICE AND PROCESS INTERRUPTION

A. All utility service and/or process interruptions initiated by the Contractor in the prosecution of his work shall be scheduled in advance and approved in writing by the appropriate Utility Company and the Owner.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit to the Engineer operation and maintenance manuals on all mechanical equipment in accordance with Specification 01730 – Operation and Maintenance Data. Two (2) copies of draft manuals shall be submitted for approval not later than the date of shipment of the equipment. Five (5) final conformed copies shall be submitted and available to Owner's personnel at least two weeks prior to start-up and instruction for each piece of equipment. Refer to Division 1.

1.07 INSTALLATION MANUALS

A. In addition to operation and maintenance manuals, the Contractor shall submit to the Engineer three (3) copies of all installation manuals for each piece of equipment. This manual shall be submitted at the same time as the operation and maintenance manual. Installation of equipment shall not be performed until installation manuals are received.

1.08 EQUIPMENT GUARANTEE

A. The Contractor shall furnish and replace, without cost to Owner, all equipment parts that are defective or show undue wear within 3 years from the date of substantial completion of the work by the Owner unless extended periods of warranty for specific pieces of equipment are specified elsewhere. In addition to performance guarantees, all processes or systems shall comply with the requirements of applicable portions of the Sections of these Specifications describing those systems.

PART 2 PRODUCTS

2.01 MATERIALS AND WORKMANSHIP

A. All equipment furnished under this Division shall be new and guaranteed free from defects in materials, design, and workmanship. These Specifications, to the extent possible, identify service conditions and requirements for all equipment; however, it shall be the manufacturer's responsibility to ascertain, to his satisfaction, the conditions and service under which the equipment will operate and to warrant that operation under those conditions will be successful. All parts of the equipment shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent or continuous operation.

B. All equipment shall be designed, fabricated, and assembled in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests. Materials shall be suitable for service conditions.

C. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment, shall have a minimum nominal thickness of 1/4 inch. The location of the fabricator and his shop schedule shall be furnished to the Engineer prior to the beginning of fabrication so that the Engineer can schedule shop inspection if so desired.

2.02 EQUIPMENT BASES AND BEDPLATES

A. Unless otherwise indicated, a 316 Stainless Steel (SS) base shall be provided for each item of equipment which is to be installed on a concrete foundation. Equipment assemblies, unless otherwise specified, or shown on the Contract Drawings, shall be mounted on a single, heavy, 316 SS bedplate. Bases and bedplates shall be provided with machined support pads, tapered dowels for alignment or mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. All seams and contact edges

between SS plates and shapes shall be continuously welded and ground smooth. The plates shall have a minimum thickness of 1/4 inch. All pump bedplates must include a drip lip and provision for directing accumulated gland leakage to a single disposal drain point.

2.03 JACKING SCREWS AND ANCHOR BOLTS

A. Jacking screws shall be provided in the equipment bases and bedplates to aid in leveling prior to grouting.

B. Equipment suppliers shall furnish anchor bolts, nuts, washers, and sleeves of adequate design as required for proper anchorage of the bases and bedplates to the concrete bases. Sleeves shall be a minimum of 1-1/2 times the diameter of the anchor bolts. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-inch of grout beneath the baseplate and to provide adequate anchorage into structural concrete. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall be 316 stainless steel which conforms to ASTM A-167 and ASTM A-267.

2.04 LUBRICATION

A. Lubrication of equipment shall ensure constant presence of lubricant on all wearing surfaces. Lubricant fill and drain openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer. The Contractor shall provide to the Owner a 1-year supply of lubricants for each piece of equipment installed. All lubricants shall be properly packaged, labeled, and delivered to the Owner concurrent with equipment installation. An inventory listing of lubricant types by equipment and quantities shall be provided.

PART 3 EXECUTION

3.01 COORDINATION

A. The Contract Drawings show, in a diagrammatic form, the arrangements desired for the principal apparatus,

piping, and similar appurtenances, and shall be followed as closely as possible. Proper judgment must be exercised in carrying out the work to secure the best possible headroom and space conditions throughout, to secure neat arrangement of piping, valves, fixtures, hangers, and similar appurtenances, and to overcome local difficulties and interference of structural conditions wherever encountered.

B. The Contractor shall take all measurement for his work at the installation sites, verify all subcontractor Drawings prior to required submittal and be responsible for the proper installation, within the available space, of the apparatus specified and shown on the Drawings. The Contractor must secure the approval of the Engineer for all variations and/or substitutions before making any changes.

3.02 PROTECTION

A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry and clean at all times. Pumps, blowers, motors, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather tight storage facilities such as warehouses. All materials and equipment showing evidence of rust, dirt contamination, or other surface or subsurface deterioration shall be cleaned and restored to the Engineer's satisfaction prior to installation.

B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted in accordance with the requirements of Section 09900 – Painting and Coatings to the satisfaction of the Engineer.

C. Electrical equipment, controls, and insulation shall be protected against moisture or water damage.

D. The Contractor shall maintain equipment storage facilities in accordance with the provisions of Division 1.

E. All equipment shall be stored in the designated storage facilities from delivery until installation.

F. All mechanical equipment, whether in the Contractor's designated storage facility prior to final installation, or whether installed, but not yet placed into service or accepted by the Owner, shall be periodically exercised at intervals, and in accordance with procedures prescribed by each manufacturer, if such a recommendation is included in the manufacturer's installation, operation and maintenance instructions.

3.03 INSTALLATION CHECK

A. The Contractor shall have an experienced, competent, and authorized representative of the manufacturer or supplier of each major item of equipment visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The Contractor shall have the equipment supplier's representative revisit the job site as often as necessary until all problems are corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Contractor, a written report certifying that the equipment: (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from all stress imposed by connecting piping or anchor bolts; and, (4) has been operated successfully under full load conditions.

C. Equipment manufacturers shall furnish the services of competent, factory-trained personnel during the warranty period specified to inspect, service, and repair the equipment where required. Service requests shall be answered and acted upon promptly. This requirement shall not include normal maintenance and service of equipment, which will be the responsibility of the Owner.

D. All costs for this work shall be included in the price bid by the Contractor.

3.04 EQUIPMENT INSTALLATION

A. All equipment shall be installed in full accordance with the equipment manufacturer's recommendations and good practice. Where specified in other parts of this Division, factory-trained service personnel shall be on-site to supervise the installation. Sufficient

notice shall be given to the Engineer prior to equipment installation in order that the Engineer or his representative may be present during installation. In general, the following installation practices shall be followed:

1. Examine equipment for damage in shipping and handling. The examination shall include checking for corrosion, poor workmanship, dirt or deleterious substances, and poor fits.

2. Level the base plate or bedplate

3. Install equipment

4. Check alignment of couplings

5. If grout has been used, check alignment and levelness after the grout has set.

6. Check direction of rotation and correct, if necessary, to insure proper operation.

7. Ensure that all submerged or intermittently submerged powered equipment does not have power and control cable splices of any kind inside wells or pits.

3.05 PLACING IN OPERATION

A. Prior to being placed in operation, equipment shall be inspected by the manufacturer's factory-trained personnel. All defects discovered during this inspection shall be corrected prior to initial equipment start-up. Internal coatings applied at the factory shall be removed if required. Lubricant shall be applied in the proper places and levels shall conform to the manufacturer's recommendations. In the presence of the Engineer, full-load operational testing shall be performed and the results of such tests shall be recorded. Unsatisfactory performance shall be corrected and tests shall be repeated until the equipment performance meets the Specifications. The Contractor shall furnish all power, materials, services, test equipment and labor required to successfully complete all full load equipment testing specified. The Contractor shall certify in writing to the Engineer, in triplicate, that all tests were conducted in accordance with these Specifications and that all components within each system successfully function as required. The Contractor shall notify the

Engineer ten (10) calendar days in advance of the time when the equipment will be placed into operation. During the course of initial operation, the Contractor shall instruct Owner's personnel in the proper operation and maintenance of the equipment, as specified herein.

3.06 INSTRUCTION

A. After the equipment specified in Divisions 11, 13, 15 and 16 has been installed, tested, adjusted, and placed in satisfactory operating condition, services of representatives of each equipment manufacturer shall be provided to instruct the operating personnel in the use and maintenance of the equipment. The instruction period shall be scheduled at a time mutually agreed upon with the Owner, prior to final acceptance. The manufacturer's representatives shall fully instruct the Owner's personnel regarding use and maintenance of the equipment. During this instruction period, it shall be the responsibility of the manufacturer to answer all questions from the Owner's operating personnel. Manufacturer shall also demonstrate lubrication, disassembly, adjusting, routine parts replacement, and other "hands-on" activities related to maintenance of the equipment. Provide a minimum of not less than eight (8) hours for this instruction for each piece of equipment or set of identical pieces of equipment provided unless otherwise specified. More days shall be provided if called for in the individual equipment specification. Each manufacturer shall include the service in the price of his equipment. Training session schedules shall be coordinated with the Owner and Engineer and under no circumstances shall more than two training sessions be scheduled for the same day. The Contractor shall designate an individual through whom manufacturer's training will be coordinated. This individual will coordinate all training sessions through Owner's designated training coordinator.

3.07 SPECIAL TOOLS AND ACCESSORIES

A. All special tools, special tool lists, equipment, or accessories required for the installation and maintenance of equipment specified in Division 11, as well as three (3) copies each of instruction manuals necessary for the proper use of such tools, equipment, or accessories shall be provided by the equipment manufacturer. Special tools shall be defined as those items manufactured by the equipment supplier specifically for performing maintenance and

installation of their respective equipment, including knocker wrenches for gearboxes.

3.08 SHOP PAINTING

A. Except as specifically supplemented or superseded by requirements herein, shop painting shall conform to requirements in Section 09900 – Painting and Coatings. Electric motors, gears, starters, and other similar self-contained or enclosed components shall be shop primed and finished with a high-grade oil-resistant acrylic enamel. Surfaces which will be inaccessible after assembly shall be painted or otherwise protected before assembly by a method which provides protection for the life of the equipment.

B. Surfaces to be painted at the project site shall be shop painted with one or more coats of a primer which will adequately protect the equipment until finishes are applied at the project site. Primers shall be as specified in Section 09900 – Painting and Coatings. All equipment shall be primed with primer compatible with the coating system selected by the Contractor, and if not, the Contractor shall reprime the equipment such that it is compatible and in conformance with Section 09900 – Painting and Coatings.

C. Machined and polished metallic surfaces which are not to be painted shall be coated with a rust preventive compound as specified in Section 09900 – Painting and Coatings.

3.09 DAMAGED PRODUCTS

A. The Contractor shall notify the Engineer in the event that any equipment or material is damaged subsequent to receipt at the job site, and prior to acceptance of the installation by the Owner.

B. Repairs to damaged products in lieu of replacement shall not be made without prior approval by the Engineer.

END OF SECTION

SECTION 11100

PUMPS - GENERAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. The requirements of Section 11001 – Equipment Basic Requirements apply to this Section.

D. Unit Responsibility: The CONTRACTOR shall be made responsible for furnishing the WORK. The Pump Manufacturer shall be responsible for the coordination of design, assembly and factory testing of the Pumps, if required. The Contractor shall be responsible to the OWNER for compliance with the requirements of each pump.

E. Single Manufacturer: Where 2 or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01310 – Shop Drawings, Project Data and Samples.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Pump name, identification number, and specification Section number.
2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand,

overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. Performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be furnished for each centrifugal pump equipped with a variable speed drive.

3. The CONTRACTOR shall require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.
4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
5. Elevation of proposed local control panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the local control panel.
6. Wiring diagram of field connections with identification of terminations between local control panels, junction terminal boxes, and equipment items.
7. Complete electrical schematic diagram.

C. Technical Manual: The Technical Manual shall contain the required information for each pump Section.

D. Spare Parts List: A spare parts list shall contain the required information for each pump Section.

E. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

F. Certifications
1. Manufacturer or manufacturer’s representative certification of proper installation.
2. CONTRACTOR'S certification of satisfactory field testing.

PART 2 – PRODUCTS

2.01 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Performance Curves: All centrifugal pumps shall have a continuously rising curve or the system operating range shall not cross the pump curve at two different capacities or “dip region.” Unless indicated otherwise, the required pump shaft horsepower at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

C. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

2.02 MATERIALS

A. All materials shall be suitable for the intended application; materials not indicated shall be high-grade, standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls or volutes shall be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal.
2. Bronze pump impellers shall conform to ASTM B 62 - Composition Bronze or Ounce Metal Castings, or B 584 - Copper Alloy Sand Castings for General Applications, where dezincification does not occur.
3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be Type 316.

4. Anchor bolts, washers, and nuts in Standard Service (Non-Corrosive Application) shall be galvanized steel in accordance with the requirements of Section 05500 - Miscellaneous Metalwork. Anchor bolts, washers, and nuts in Corrosive Service as defined in Section 05500 shall be stainless steel in accordance with that Section.

B. Materials in contact with potable water shall be listed as compliant with NSF Standard 61.

2.03 PUMP COMPONENTS – GENERAL

A. Flanges and Bolts: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Bolts shall be in accordance with Section 05500.

B. Lubrication: Vertical pump shafts of clean water pumps shall be product water lubricated, unless otherwise indicated. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed line shafts. Pumps for sewage, sludge, and other process fluids shall be lubricated as indicated.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Drains: All gland seals, air valves, cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

E. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

F. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the manufacturer's suggested materials best suited for the specific application. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

1. Conventional Packing Gland Type Seal: Unless otherwise indicated, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following. Acceptable ring materials are asbestos-free die-molded packing rings of braided graphite material free of PTFE, Chesterton 1400R, or equal for non-potable water service and braided PTFE material, Chesterton 1725 or equal that is listed under NSF Standard 61 for potable water service.

Shaft speeds	up to 2500 fpm
Temperature	up to 500 degrees F
pH range	0-14

2. Mechanical Seals (Conventional Non-Split Type): Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 88, Flowserve Type ISCPP, Chesterton Type GDS or 255
Water Pumps (hot and cold)	Single seals	John Crane Type 88SRS, Flowserve Type ISCPX, Chesterton Type UV, GSS, or 155

3. Mechanical Seals (Split Type): Split type mechanical seals shall be fresh water flushed unless indicated otherwise; in which case product

water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following or equal

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 3710, Flowserve Type PSS2, Chesterton Type 442
Abrasives, Grit, or Lime Slurry Pumps	Double seals	Split seals are not recommended.
Chemicals or Corrosive Liquid Pumps	Single seals	Split seals are not recommended because of leakage.
Water Pumps (hot and cold)	Single seals	John Crane Type 3710, Flowserve Type PSS II, Chesterton Type 442

4. Mechanical Seals (Tandem Type): Tandem type mechanical seals shall have an oil chamber between the seals. The seals shall be used with the rotating seal faces being carbon and the stationary seal faces to be ceramic. The lower seal shall be replaceable without disassembly of the seal chamber and without the use of special tools. Pump-out vanes shall be present at the back of the impeller to keep contaminants out of the seal area. Tandem Type Mechanical Seals shall be John Crane type 21, BF1C1.

G. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

H. Mechanical seals for all services shall be equipped with nonclogging, flexible–mounted seats with elastomer secondary seals. Wetted metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C, whichever has the best corrosion resistance to the pumped fluid.

Dual cartridge seals shall be double balanced to allow for seal integrity in case of flush water pressure reversal. All single and double seals shall have springs in the non-wetted end of the seal.

I. Fresh water shall be delivered to the seals through appropriate size piping with plug valves, strainers, pressure regulators, electrically operated solenoid valves, and rotameters. Wiring shall comply with Division 16 and solenoid control shall comply with Division 17.

2.04 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Solenoid Valves: The pump manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines if seal water flush is required. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges

1. All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
2. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

2.05 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system:

1. Pump Systems: All centrifugal pump systems with drives 10 hp up to and including 150 hp shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) acceptance Level "A" or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and

published by the Hydraulic Institute. For sump pumps, acceptance shall be in accordance with Level "B" of ANSI/HI 1.6 unless indicated otherwise. For pumps with motors of 100 hp or less, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test results shall be submitted:

a. Hydrostatic test results
b. At maximum speed, a minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
   For variable speed driven pumps, each pump shall be tested between maximum and minimum speed at 100 rpm increments.
c. Pump curves showing head, flow, bhp, and efficiency requirements.
d. NPSH required test curve if required by the pump specification. Otherwise, a calculated NPSH required curve may be submitted.
e. Certification that the pump shaft horsepower demand did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

2. Factory Witnessed Tests: All pumps, and motors, 150 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the OWNER and ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. All costs for OWNER and ENGINEER shall be borne by the CONTRACTOR and shall be included in the bid price. Such costs shall include travel and subsistence for two people excluding salaries. Test results shall be submitted to the ENGINEER. No equipment shall be shipped until the test data have been approved by the ENGINEER.
3. Acceptance: In the event of failure of any pump to meet any of the requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract

Documents and the pump shall be re-tested until found satisfactory.

PART 3 – EXECUTION

3.01 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the manufacturer shall visit the Site for the number of days indicated in those sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment
2. Inspection, checking, and adjusting the equipment
3. Startup and field testing for proper operation
4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements

B. Instruction of the Owner's Personnel

1. Where required by the individual pump Sections, an authorized training representative of the manufacturer shall visit the Site for the number of days indicated in those Sections to instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
2. The representative shall have at least 2 years experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of 3 weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The OWNER may videotape the training for later use with the OWNER'S personnel.

3.02 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment and freedom from binding, scraping, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation.

3.03 PROTECTIVE COATING

A. Materials and equipment shall be painted as required in Section 09900 – Painting and Coatings.

3.04 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate:

1. Satisfactory operation without excessive noise and vibration.
2. No material loss caused by cavitation.
3. No overheating of bearings.
4. Indicated head, flow, and efficiency at design point.

B. The following field testing shall be conducted:

1. Startup, check, and operate the pump system over its entire speed range. If the pump is driven by a variable speed drive, the pump and motor shall be tested at 100 RPM increments. If the pump is driven at constant speed, the pump and motor shall be tested at max RPM. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each

pump rotational speed if variable speed at 100 RPM increment or at max RPM if constant speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time until bearing temperatures have stabilized shall precede this test, unless insufficient liquid volume is available.
4. Electrical and instrumentation tests shall conform to the requirements of the sections under which that equipment is specified.

C. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish 3 days advance notice of field testing.

D. In the event any pumping system fails to meet the indicated requirements, the pump shall be modified or replaced and re-tested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The CONTRACTOR shall be responsible for all costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear. If available, the OWNER'S operating personnel will provide assistance in field testing.

END OF SECTION

SECTION 11290

SLIDE GATES

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Work shall include furnishing and installing rising stem, ASTM-B 221, 6061-T6 aluminum slide gates. Each complete with integral frame, stem, stem guides and operator. The requirements for gates, with corresponding operators, have been summarized in the Gate Schedule on the Drawings.

B. Location shall be as shown on the Drawings.

C. Related Work Specified Elsewhere:

1. Section 05500 - Metal Fabrications

2. Section 09900 - Painting and Coatings

1.02 QUALITY ASSURANCE

A. Slide gate including the frame, stem, guides and operator shall be furnished by one manufacturer.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:

1. Rodney Hunt Company

2. Hydro Gate Corporation

3. Washington Aluminum Company

4. Whipps, Inc.

5. Or Approved Equal

1.03 SUBMITTALS

A. Submit shop drawings, fully dimensioned with installation details.

B. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

1.04 OPERATION AND MAINTENANCE MANUALS

A. Operations and Maintenance Manuals shall be submitted as outlined in Specification 01730 – Operation and Maintenance Data.

1.05 WARRANTY

A. Per General Condition Article 9, the Contractor shall provide a 3-year warranty from substantial completion.

PART 2 PRODUCTS

2.01 SLIDE GATES

A. The slide gates, where shown on the Drawings, shall be fabricated ASTM B 221, 6061-T6, aluminum self-contained type, with the disc arranged to lower to open and with the guides designed to mount on the face of a concrete wall. All parts of the gates shall be a minimum thickness of 1/4-inch.

B. The guides shall be of ASTM B 221, 6061-T6, aluminum incorporating a dual slot design. The primary slot shall accept the plate of the disc and the secondary slot will be sufficiently wide to accept the reinforcing ribs of the disc. The guides shall be designed for maximum rigidity, shall have a weight of not less than three pounds per linear foot and will be provided with holes for anchor bolts every 18-inches for face mounted units. Guides shall extend beneath the opening a sufficient amount to support the disc in the fully down or open position for downward opening gates. The guides shall be furnished with high density polymer seats for ease of operation. The seat material shall be made of ultra-high molecular weight polymer having an intrinsic viscosity of at least 14. The seats shall be firmly welded in a dovetail groove in the frame and shall be placed on both sides of the gate disc. The seats shall extend up to the top of the two vertical guides above the operating floor.

C. An ASTM B 221, 6061-T6, aluminum angle shall be welded to the guides across the invert of the opening on face mounted gates and up both sides of all gates. A hollow bulb J-seal shall be attached to this angle with stainless steel strips and attaching bolts. The seal

shall be arranged so that it will deflect a minimum of 1/16-inch.

D. The invert of embedded unit frames shall have an angle welded to the lower ends of the guides to form a seating surface for a resilient seal mounted on the disc or may install the rubber seal in the bottom frame.

E. Where guides extend above the operating floor, they shall be sufficiently constructed so that no further reinforcing will be required. Where required, the yoke to support the operating bench stand shall be formed by two angles welded at the top of the guides to provide a one piece rigid frame. The arrangement of the yoke shall be such that the disc and stem can be removed without disconnecting the yoke. The yoke shall be designed to deflect no more than 1/360 of its span under full operating load.

F. Disc: The disc or sliding member shall be of ASTM B 221, 6061-T6, aluminum plate reinforced with "U shaped" ASTM B 221, 6061-T6, aluminum extrusions welded to the plate not more than 16-inches apart. The disc shall not deflect more than 1/360 of the span of the gate under the design head. The working design stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the ASTM B 221, 6061-T6, aluminum components. All disc components shall have a minimum material thickness of 1/4-inches. Reinforcing ribs shall extend into the guides so that they overlap the seating surface of the guide. A specially shaped resilient seal shall be mounted on the bottom of the disc to provide flush-bottom closure. The shape of the seal shall produce a seating surface having a minimum width of 3/4-inch and the seal shall extend into the secondary slot of the vertical guide. The vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the corners. Leakage shall not exceed 0.1 gallon per minute per foot of seating perimeter.

G. Stem: The operating stem shall be ASTM-A-276 Type 304 stainless steel designed to have an L/r of less than 200 and to withstand in compression at least twice the rated output of the bench stand. The stem shall be connected to the disc by means of a bolted connection. The rising stem shall be provided with a clear butyrate plastic stem cover with mylar positioning markers.

H. All necessary attaching bolts and anchor bolts shall be

ASTM-A-276 Type 316 stainless steel and shall be furnished by the slide gate manufacturer.

I. Operator: Unless noted otherwise on the Drawings, operation of the gate shall be by means of a hand wheel or crank operated bench stand mounted on the yoke of the gate. The bench stand shall be fully enclosed, equipped with roller bearings above and below the operating nut. On a crank operated bench stand, the pinion shaft shall be cadmium plated and supported on roller bearings. A mechanical seal shall be provided around the pinion shaft where it extends from the hoist enclosure.

J. The hoist shall be sized to permit operation of the gate under the full operating load with a maximum effort of 40 lbs. on the crank or hand wheel. The hoist nut shall be manganese bronze; conforming to ASTM B584 C86500. The hoist nut shall be supported on roller bearings. A lubrication fitting shall be provided for lubrication of the hoist bearings without disassembly of the hoist. Suitable seals shall be provided to prevent entry of foreign matter. The direction of hand wheel or crank rotation to open the gate shall be clearly and permanently marked on the hoist. Where the actuators are to be interconnected, it shall be by means of a flexible coupling and stainless steel tubing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the drawings and the manufacturers instructions.

3.02 FIELD TESTING

A. The slide gate shall be tested by operating it to fully open and back to fully closed.

END OF SECTION

SECTION 11291

SLUICE GATES

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. This section includes furnishing all labor, materials, equipment and incidentals required, and installing and field testing the stainless steel sluice gates and operators.

1.02 GENERAL

A. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the ENGINEER.

B. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of sluice gates.

C. Gates supplied under this section shall be Series 20 stainless steel flow control sluice gates as manufactured by H. Fontaine Ltd.

1.03 QUALITY ASSURANCE

A. The manufacturer shall have experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 50 installations. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX.

B. Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA C561, latest edition.

C. Gates shall be shop inspected for proper operation before shipping.

D. The manufacturer shall be ISO 9001: 2000 certified.

E. Leakage:

1. Sluice gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.05 U.S. gallon per minute per foot of seating perimeter. Under the design unseating head, the leakage for heads of 20 feet or less shall not exceed 0.1 U.S. gallon per minute per foot of perimeter. For unseating heads greater than 20 feet, the allowable leakage shall not exceed the rate per foot of perimeter specified by the following equations:

   Maximum allowable leakage:

   Gallons per minute per foot of perimeter:
   = 0.10 + [0.0025 x (unseating head in feet - 20)]

F. Design Head:

1. The sluice gates shall be designed to withstand the design head shown in the schedule.

G. Seal Performance Test:

1. The gate's sealing system shall have been tested through a cycle test in an abrasive environment and shall show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

1.04 SUBMITTALS

A. The manufacturer shall submit for approval by the purchaser, drawings showing the principal dimensions, general construction and materials used in the gate and lift mechanism.

PART 2 – PRODUCTS

2.01 SLUICE GATES

A. General Design:

1. Gates shall be self-contained of the rising stem configuration.

B. Frame:

1. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

2. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the concrete.

C. Slide:

1. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.

D. Guides and Seals:

1. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

2. Side and top seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.

3. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

2.02 OPERATORS AND STEM

A. Stem and Couplings:

1. The operating stem shall be of stainless steel designed to transmit in compression at least 2 times

the rated output of the operating manual mechanism with a 40 pound effort on the crank or handwheel.

2. The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type.

3. Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.

   a. For stems in more than one piece and with a diameter of 1¾ inches and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1¾ inches shall be pinned to an extension tube.

   b. The couplings shall be grooved and keyed and shall be of greater strength than the stem.

   c. Gates having a width greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

B. Stem Guides:

1. Stem guides shall be fabricated from type 316L stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

C. Stem Cover:

1. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

D. Lifting Mechanism:

1. Manual operators shall be provided by the gate manufacturer.

2. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.

3. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lbs.

4. The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.

E. Yoke:

1. Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection of the yoke shall be 1/360 of the gate's span.

2.03 MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel Type 316L
Side seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D-4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Bottom seal	Neoprene ASTM D2000 Grade 2 BC 510
Threaded stem	Stainless steel Type 316
Fasteners	ASTM GR2 for type 316
Pedestal, handwheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D-3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS-C86500

2.04 SLUICE GATE SCHEDULE

A. See Drawing No. M-1.1

B. Gate Type:

1. Isolation Sluice Gate

2. Wall-Mounted

3. Self-Contained Frame

4. Yoke-Mounted Handwheel Operator

5. Rising Stem

PART 3 – EXECUTION

3.01 INSTALLATION

A. Gates and appurtenances shall be handled and installed in accordance with the manufacturer's recommendations.

3.02 FIELD TESTS

A. Following the completion of each gate installation, the gates shall be operated through at least two complete open/close cycles. If an electric or hydraulic operator is used, limit switches shall be adjusted following the manufacturer's instructions.

B. Gates shall be checked for leakage by the Contractor (refer to Paragraph 1.03.E.1 for the leakage test).

END OF SECTION

SECTION 11304

NON-CLOG SUBMERSIBLE SEWAGE PUMPS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. The Work includes providing and installing a Reclaimed Water Return Pump Station with triplex pumps and a Disk Filter Waste Backwash Pump Station with duplex pumps. The pump operating characteristics for each pump station shall conform to the requirements shown in Tables 11304-1 and 11304-2 at the end of this Section.

2. Furnish, install, and test submersible sewage pumps, motors, and related equipment necessary to complete work shown or specified.

3. Equipment shall include pump(s), motor(s), pump base(s), guide rail systems, access frames & covers, precast concrete and wet wells, electric power systems, control systems, and appurtenances. Provide all components of the pumping units by one manufacturer.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03455 – Precast Concrete Manholes

B. Section 05531 – Access Hatches

C. Section 13300 – Instrumentation and Controls, General Requirements

D. Division 16 - Electrical

1.03 REFERENCES

A. Codes, Specifications, and Standards: Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the references thereto.

1.04 SUBMITTALS

A. Submittals shall be as specified in the General Conditions and Section 01310 – Construction Schedule and Project Restraints.

B. Submit the following:

1. Manufacturer’s Certificate of Compliance certifying compliance with the referenced specifications and standards.

2. Shop drawings with performance data and physical characteristics.

3. Manufacturer’s installation instructions.

4. Manufacturer’s operation and maintenance material and manuals (see Section 01730).

5. Certified copies of test reports.

1.05 QUALITY ASSURANCE

A. The pumping unit manufacturer shall test each pump for mechanical and electrical correctness.

B. The Contractor shall perform field tests specified in this Section.

C. The Contractor shall provide certification of the wet well H-20 load rating with the wet well submittals. The H-20 certifications must be signed and sealed by an Engineer registered in the State of Florida. After the wet wells have been installed, the ASTM certification number and serial tracking numbers must be visible.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall be responsible for the delivery, storage, and handling of products.

B. The Contractor shall load and unload all pumps, motors, precast concrete and wet wells and appurtenances by hoists or skidding. Products shall not be dropped or skidded on or against other

products. Slings and hooks shall be padded in such a manner as to prevent damage to products.

C. The Manufacturer shall package the pumping units furnished in such a manner as to provide ample protection from damage during handling, shipment, and outdoor storage at the project site. The Manufacturer shall cap all openings with dustproof closures and seal or tape all edges to provide a dust-tight closure.

D. Promptly remove damaged products from the job site. Replace damaged products with undamaged products.

1.07 WARRANTY

A. Provide warranties from the pump manufacturer warranting the complete units being supplied to the OWNER against defects in workmanship and material for a period of five (5) years or 10,000 hours under normal use, operation and service. The Contractor shall provide the warranties in printed form and submit them with the shop drawing submittals.

B. The Contractor shall provide written 20-year warranties on the H-20 load rated precast concrete wet wells.

C. Warranties and guarantees by the suppliers of various components in lieu of a single source responsibility by the manufacturer will not be accepted. The manufacturer shall be solely responsible for the warranty of the submersible pumps and all components.

D. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the manufacturer shall provide and install a replacement part without cost to the Owner.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURER and MODEL

A. Reclaimed Water Return Pump Station: Hydromatic Model S8L Non-Clog Submersible Pump.

B. Disk Filter Waste Backwash Pump Station: Hydromatic Model S4N Non-Clog Submersible Pump.

2.02 NON-CLOG SUBMERSIBLE CENTRIFUGAL PUMPS, GUIDE RAIL BASE AND GUIDE RAIL DESIGN

A. The pumps shall be capable of handling raw unscreened sewage, storm water, reclaimed water from open storage ponds, disk filter waste backwash, and other similar solids-laden fluids without clogging. The pumps shall be installed in the H-20 precast concrete wet wells utilizing dual guide rail systems. Each discharge base and elbow shall be permanently installed in the wet wells and connected to the discharge piping. In order to prevent binding or separation of each pump from its guide rail system, the pump shall connect to the guide rail base automatically and firmly, guided by the 316 stainless steel guide rail extending from the top of the station to the discharge connection. Cable guide systems shall not be considered acceptable. Each pump shall be fitted with a 316 stainless cable of adequate strength to permit raising the pump for inspection. The working load of each lifting system shall be 50 percent greater than the pump unit weight. There shall be no need for personnel to enter the wet well to remove or reinstall each pump. Positive sealing of each pump to the discharge elbow shall be accomplished by metal to metal contact between the pump and discharge elbow. No portion of each pump shall bear directly on the floor of the sump. Each pump with its appurtenances and cable shall be capable of continuous submergence to a depth of 65 feet.

2.03 PUMP CONSTRUCTION

A. Major pump components shall be of gray cast iron, ASTM A-48, Class 30, with smooth surfaces devoid of porosity or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts, bolts and fasteners shall be AISI type 316 stainless steel construction. All exterior metal surfaces of the pump coming into contact with the

pumped media (other than the stainless steel or brass components) shall be protected by a factory applied spray coating of dark green, water reducible enamel.

B. Sealing design for the pump/motor assembly shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where a watertight seal is required shall be machined and fitted with Buna-N rubber O-rings sealed on a beveled edge. Sealing will be the result of controlled compression of a rubber O-ring in two planes and O-ring contact of four sides without requiring a specific torque limit. No secondary sealing compounds, elliptical O-rings, grease, or other devices shall be used.

C. The pump casing or volute shall be single piece gray cast iron, ASTM A48, Class 30, non-concentric design with smooth passages large enough to pass any solids, which may enter the impeller. Minimum discharge size shall be as specified. The casing shall be of the end suction volute type having sufficient strength and thickness to withstand all stress and strain from service at full operating pressure and load. The casing shall be of the centerline discharge type equipped with an automatic pipe coupling arrangement for ease of installation and piping alignment. The design shall be such that the pumps will be automatically connected to the discharge piping when lowered into position with the guide rails. The casing shall be accurately machined and bored for register fits with the suction and casing covers.

D. A volute case wearing ring shall be provided to minimize impeller wear. The wear ring shall be alloy 230 brass, ASTMB-43 and held by 300 series stainless steel fasteners. The wear ring shall be easily replaceable in the field.

E. The impeller shall be of gray cast iron, ASTM A48, Class 30, dynamically balanced, 2-vane non-clogging design having a long throughlet without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. The

impeller shall be threaded shaft or tapered shaft and key driven. A 300 Series stainless steel washer and impeller bolt shall be used to fasten the impeller to the shaft. Impeller shall have pump-out vanes on the front and backside of the impeller to prevent grit and other materials from collecting in the seal area. Single vane design impellers which cannot be easily trimmed and which do not maintain balance with wear causing shaft deflections that reduce seal and bearing life, are not acceptable. Impeller shall not require coating. Because most impeller coatings do not remain beyond the very early life of the impeller, efficiency and other performance data submitted shall be based on performance with an uncoated impeller. Attempts to improve efficiency by coating impeller shall not be acceptable.

F. The pump shaft and motor shaft shall be an integral unit. Each shaft shall be of 303 stainless steel material and adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall be machined from solid 303 stainless steel stock to produce a shaft with a large diameter and minimum overhang to reduce deflection and prolong bearing life.

G. An upper radial bearing and a lower thrust bearing shall be required. These shall be heavy-duty single row ball bearings which are permanently lubricated by the dielectric oil which fills the motor housing. Double row, sealed grease packed bearings shall not be acceptable. Bearings which require lubrication according to a prescribed schedule shall not be acceptable. The upper radial bearing shall have a minimum B-10 life at the specified condition of 50,000 hours and the lower thrust bearing shall have a minimum B-10 life at the specified condition of 50,000 hours. Bearings shall be locally available.

H. The pump shall have two mechanical seals, mounted in tandem, with an oil chamber between the seals. John Crane Type 21, seals shall be used with the rotating seal faces being carbon and the stationary seal faces ceramic. The lower seal shall be replaceable without disassembly of the

seal chamber and without the use of special tools. Pump-out vanes shall be present on the backside of the impeller to keep contaminants out of the seal area. Units which require the use of tungsten-carbide seals or foreign manufactured seals shall not be acceptable. Seals shall be locally available.

The pump shall be equipped with a seal leak detection probe and warning system. This shall be designed to alert maintenance personnel of lower seal failure without having to take the unit out of service for inspection or requiring access for checking seal chamber oil level and consistency.

There shall be an electric probe or seal failure sensor installed in the seal chamber between the two tandem mechanical seals. If the lower seal fails, contaminants which enter the seal chamber shall be detected by the sensor and send a signal to operate the specified warning device.

Units equipped with opposed mechanical seals shall not be acceptable.

2.04 MOTORS

A. The stator, rotor and bearings shall be mounted in a sealed submersible type housing. The stator windings shall have Class F insulation, (155°C, or 311°F.), and a dielectric oil filled motor, NEMA B design (3 phase).

B. The pump and motor shall be specifically designed so that they may be operated partially dry or completely submerged in the liquid being pumped. The pump shall not require cooling water jackets. Dependence upon, or use of, water jackets for supplemental cooling shall not be acceptable.

C. Stators shall be securely held in place with a removable end ring and threaded fasteners so they may be easily removed in the field without the use of heat or a press. Stators held by a heat shrink fit shall not be acceptable. Stators shall be capable of being repaired or rewound by a local motor service station. Units which require service only by the factory shall not be

acceptable. No special tools shall be required for pump and motor disassembly.

D. Pump shall be equipped with heat sensors. The heat sensors, (two on three phase), shall be low resistance, bi-metal disc that is temperature sensitive. They shall be mounted directly in the stator and sized to open at 120°C or 130° C, and automatically reset at 30-35°C differential. The sensor shall be connected in series with the motor starter coil so that the starter is tripped if a heat sensor opens. The motor starter shall be equipped with overload heaters 3-leg on three phase) so all normal overloads are protected by an external heater block.

E. Each motor for the Reclaimed Water Return Pump Station shall be inverter duty rated in accordance with NEMA MG1, Part 31.

F. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and shall be capable of no less than 15 evenly spaced starts per hour.

G. The pump shall be triple protected with a compression fitting and two epoxy potted areas at the power cord entry to the pump. A separation between the junction box areas of the pump and the motor by a stator lead sealing gland or terminal board shall not be acceptable.

H. The power cable entry into the cord cap assembly shall first be made with a compression fitting. Each individual lead shall be stripped down to bare wire at staggered intervals, and each strand shall be individually separated. This area of the cord cap shall then be filled with an epoxy compound potting which will prevent water contamination to gain entry even in the event of wicking or capillary attraction.

I. The power cord leads shall then be connected to the motor leads with extra heavy connectors having brass inserts with a screwed wire to wire connection, rather than a terminal board.

J. The connection box wiring shall be separated from the motor housing wiring by stripping each lead down to bare wire, at staggered intervals, and separating each strand. This area shall be filled with an epoxy compound potting. Fiberglass terminal boards which are subject to heat fatigue and cracking, and which may lead to possible leaks shall not be acceptable.

K. The cord cap assembly where bolted to the connection box assembly, and the connection box assembly, where bolted to the motor housing, shall each be sealed with a Buna N Rubber O-ring on a beveled edge to assure proper sealing.

L. 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.

M. The power cable shall be minimum 600 volts, 60°C, 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 and water resistant chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet or greater.

N. 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.

O. The motors shall be sufficiently cooled by their oil-filled casing. A water jacket is not required.

2.05 PUMP STATION CONTROL PANELS AND COMPONENTS

A. General: This section specifies the electrical power system requirements for the two submersible pump stations. These requirements apply to duplex and triplex pump panels. The manufacturer of the control panels shall provide data to indicate that the manufacturer has a minimum of 3 years experience in the fabrication of pump control panels. A triplex pump panel shall be fabricated for the Reclaimed Water Return Pump Station and a duplex pump panel for the Disk Filter Waste Backwash Pump Station.

B. Panel Construction: The duplex and triplex pump panels shall be assembled and built by a UL508A certified manufacturing facility. The duplex panel shall be housed in a NEMA 4X, minimum 30″x30″x10″ deep Type 316, 14 gauge stainless steel enclosure. The triplex panel shall be housed in a NEMA 4X, minimum dimensions 48″L x 48″W x 10″D, 14 gauge, Type 316 stainless steel enclosure. Each enclosure shall incorporate a three-point latch with two other fasteners and shall have provisions for padlocking the door and a dead front inner door unit for mounting controls. All exterior hardware and hinges shall be stainless steel.

Each panel shall have permanently affixed to the interior side of the exterior enclosure door both a nameplate and a 10" x 12" pocket for log sheet storage. The nameplate shall contain the following information: voltage, phase, rated horsepower, speed, date manufactured, pump and control panel manufacturer's name, address and telephone number, pump data, including impeller data, discharge capacity (gpm) and head (ft.), kW input, and amps at the operating point and at least two other points on the pump curve.

Each enclosure shall have external mounting feet to allow for mounting to unistrut channels. All hardware shall be stainless steel.

C. The following components shall be mounted through each enclosure:

1. 1 ea. Red Alarm Beacon (Light)
2. 1 ea. Alarm Horn

3. 1 ea. Generator Receptacle with weatherproof cover.
4. 1 ea. Alarm Silence Pushbutton

D. The back panel in each enclosure shall be fabricated from 0.125, 5025-H32 marine alloy aluminum. All components shall be mounted by machined stainless steel screws. The following components shall be mounted to the back panel of the duplex pump station enclosure:

1. 2 ea. Motor Contactors
2. 1 ea. Phase Monitor (Three Phase)
3. 1 ea. Control Transformer (480 Volt only)
4. 1 ea. Silence Relay
5. 1 ea. Model BOAC5AH Battery Back-Up with Smart Charger (per DEP)
6. 20 ea. Terminals for Field Connections
7. 3 ea. Grounding Lugs
8. 1 ea. Auto/Lead/Lag Selector Switch

E. The following components shall be mounted to the back panel of the triplex pump station enclosure:

1. 3 ea. Motor Contactors
2. 1 ea. Phase Monitor (3 Phase)
3. 1 ea. Control Transformer (480 volt only)
4. 1 ea. Silence Relay
5. 1 ea. Model BOAC 5AH Battery Back-Up with Smart Charger (per DEP)
6. 30 ea. Terminals for Field Connections
7. 4 ea. Grounding Lugs
8. 1 ea. Auto/Lead/Lag/Lag2/Selector Switch

F. The inner door of each enclosure shall be fabricated from 0.080, 5052-H32 marine alloy aluminum. The inner door shall have a continuous aluminum piano hinge. The following components shall be mounted through the inner door for the duplex pump station enclosure:

1. 1 ea. Main Circuit Breaker
2. 1 ea. Emergency Circuit Breaker
3. 1 ea. Mechanical Interlock for Emergency and Main Breakers
4. 2 ea. Short Circuit Protectors
5. 1 ea. Control Circuit Breaker
6. 2 ea. Hand-Off-Auto Selector Switches

7. 2 ea. Pump Run Pilot Lights
8. 1 ea. Power On Pilot Light
9. 2 ea. Elapsed Time Meters (Non-Resetable)
10. 1 ea. GFI Duplex Convenience Outlet

G. The following components shall be mounted through the inner door for the triplex pump station enclosure:

1. 1 ea. Main Circuit Breaker
2. 1 ea. Emergency Circuit Breaker
3. 1 ea. Mechanical Interlock for Emergency and Main Breakers
4. 3 ea. Short Circuit Protectors
5. 1 ea. Control Circuit Breaker
6. 3 ea. Hand-Off-Auto Selector Switches
7. 3 ea. Pump Run Pilot Lights
8. 1 ea. Power On Pilot Light
9. 3 ea. Elapsed Time Meters (Non-Resetable)
10. 1 ea. GFI Duplex Convenience Outlet

H. Component Specifications:

1. All circuit breakers shall be molded thermal magnetic. The mechanical interlock shall prevent the normal and emergency main breakers being energized at the same time.

2. An emergency generator receptacle shall be supplied in accordance with DEP standards. The generator receptacle shall be adequately sized to meet the equipment operating conditions.

3. All motor short circuit protection devices must provide for under voltage release and Class 10 overload protection on all three phases. Visible trip indication, test, and reset capability must be provided without opening inner door.

4. Open frame, across the line, contactors shall be rated per IEC standards and properly sized per the motor requirements. Contactors shall provide for safe touch power and control terminals.

5. Lightning arrestor for each enclosure shall meet or exceed the requirements of ANSI/IEEE Std.

C62.21-1984 Section 8.6.1 and 8.7.3, and shall be supplied by electrician and mounted on the bottom side of the switch disconnect ahead of the pump control panel.

6. A phase monitor shall be supplied for three phase service.

7. A green pilot light shall be supplied for each motor. The pilot light shall illuminate each time the motor is called to run.

8. Each pump shall have an Elapsed Time Meter to record the accumulated run time. The ETM shall be 2″ diameter, non-resettable, six digit, totally encapsulated unit.

9. A red pilot light shall be supplied for control power. The pilot light shall illuminate when the control power is available inside the control panel.

10. Relays shall be ice-cube plug-in type. Relay contacts shall be rated 10 amp minimum, DPDT.

11. Twenty (20) terminals shall be supplied for field connections for the duplex pump control panel. Thirty (30) terminals shall be supplied for field connections for the triplex pump control panel. The terminals shall be rated 25 amps minimum.

12. Each motor over-temperature contact shall be connected to the terminal strip and shall open a contact to de-energize the appropriate motor upon a high temperature within the motor.

13. A 15 amp GFI duplex receptacle shall be supplied and mounted on the inner door of each enclosure.

14. Grounding lugs shall be supplied and appropriately sized for each motor and for the service entrance.

15. Nameplates for the inner door and back panel shall be of a graphic design, specifically depicting the intent for each device.

16. The Lead/Lag Selector Switch for the duplex pump station shall have selections as follows: Auto/Pump 1, Pump 2/Pump 2Pump 1.

17. The Lead/Lag 1/Lag 2 Selector Switch for the triplex pump station shall have selections as follows: Auto/Pump 1, Pump2, Pump 3/Pump 2, Pump 3, Pump 1/Pump 3, Pump 1, Pump 2.

18. MISCELLANEOUS: All wiring on the back panel shall be contained within the wiring duct. All wiring between the inner door and the back panel shall be contained within a plastic spiral wrap. Each wire shall have a wire number at each end to correspond to the as-built drawing for field troubleshooting.

2.06 PUMP STATION CONTROL SYSTEMS

A. All control components shall be mounted in the same enclosures as the power system components. Control switches shall provide means to operate each pump manually or automatically. When operated in the automatic mode, the control assembly shall provide means to manually select or automatically alternate the position of the "lead" and "lag" or the “lead”, “lag1”, and “lag 2” pumps after each pumping cycle. The control panels shall also provide electrical tracking provisions for any SCADA systems.

B. A pump station control panel shall be provided for the Waste Backwash pump station. The control panel shall respond to liquid level float switches to automatically start and stop pumps as well as sound an alarm upon high wet well levels. The control panel shall operate two (2) electric submersible pumps at the power characteristics stipulated. The control function shall provide for the operation of the lead pump under normal conditions. If the incoming flow exceeds the pumping capacity of the lead pump, the lag pump shall automatically start to handle this increased flow. As the flow decreases, pumps shall be cut off at an elevation as shown on the Drawings. Pumps shall alternate positions as lead pump at the end of each cycle. A failure of the alternator shall not disable the pumping system.

C. A pump station control panel shall be provided for the Reclaimed Water Return Triplex Pump Station. The Control Panel shall respond to commands from a plant operator in the master control room of the wastewater treatment plant using the SCADA system. The plant operator shall be able to select the number of pumps to be in operation depending upon system demand. One reclaimed water return pump will provide flow rates between zero and 5 MGD. Two pumps will provide flow rates between 5 and 10 MGD, and 3 pumps will provide flow rates between 10 and 15 MGD. The plant operator, through usage of the SCADA system shall be capable of selecting a flow rate for the one, two or three pumps in operation. The control panel shall receive flow rate signals from a flowmeter on the discharge pipe of the pump station and adjust one, two or three pump speeds to meet the required flow rate. The flow will be monitored in the master control room of the wastewater treatment plant using the SCADA system. Each of the 3 pumps shall be capable of adjusting its output by adjusting its RPM speed using a VFD. The control panel shall respond to liquid level float switches to sound an alarm and warn plant operations personnel of very high water levels in the North Pond Reclaimed Water Return Pump Station wetwell. The control panel shall respond to liquid level float switches to sound an alarm and warn the plant operators of very low levels in the pump station wetwell. The control panel shall shut off any of the 3 pumps that are in operation when the low level signal is received. The Control Panel shall operate three (3) electric submersible pumps at the power characteristics stipulated. The control function shall provide for the operation of the “lead”, “lag 1”, and “lag 2” pumps, depending upon the number of pumps selected by the operator. The plant operator shall be capable of stopping the pumps at any time by issuing a command to the Control Panel through the plant SCADA system. The pumps shall alternate positions as the “lead” pump at the end of each pumping cycle. A failure of the alternator shall not disable the pumping system.

2.07 METAL – TO – METAL GUIDE RAIL SYSTEM AND ACCESSORIES

A. General – The Contractor shall furnish guide rail systems and accessories for each pump station. The guide rail system and accessories shall include discharge base elbows, sealing flanges with rail guides, guide rails, upper guide brackets, intermediate guide bar brackets, lifting chains or cables, cable brackets, and access hatches and frames.

B. Discharge Base Elbow

1. A discharge base elbow, designed to mount directly on the sump floor, shall be supplied for each pump. It shall have a standard 125 pound flange faced and drilled on the outlet side, with a machined mating inlet connection. The design shall be such that the pump to discharge connection is made without the need for any nuts, bolts, or gaskets. The base elbow shall also anchor and align the pair of 2″ guide rails for each pump for the Waste Backwash Pump Station and the pair of 3″ guide rails for each pump for the Reclaimed Water Return Pump Station.

C. Sealing Flange with Rail Guide

1. A sealing flange/rail guide bracket shall be mounted on each pump discharge. It shall have a machined mating flange which matches the base elbow discharge connection. Sealing of this discharge connection shall be accomplished by a simple linear downward motion of the pump culminating with the entire weight of the pumping unit supported entirely by the base elbow.

D. Guide Rail

1. The dual rail guide design shall keep each pump in proper alignment with its stationary discharge piping. These rails shall be 2″-316 stainless steel pipe which bolt directly to the base elbow and to the access frame at the top of the wet-well by using an upper guide rail bracket for the Waste Backwash Pumping Station and Reclaimed Water Return Pump Station.

E. Upper Guide Bracket

1. The upper guide bracket shall align and support the two guide rails for each pump at the top of the wetwell. It shall bolt directly to the hatch frame and incorporate an expandable rubber grommet for secure rail installation. The upper guide rail bracket shall be fabricated from 316 stainless steel.

F. Intermediate Guide Bracket

1. The intermediate guide bracket shall align and support the pair of guide rails for each pump about halfway between the top and bottom of the wetwell for the Reclaimed Water Return Pump Station. The intermediate guide bracket shall be supported by the discharge pipe and by bracing connected to the wetwell wall. The intermediate guide bar bracket shall be fabricated from 316 stainless steel.

G. Lifting Chain/Cable

1. Each pumping unit shall be provided with a 316 stainless steel lifting chain or cable of sufficient length to extend from the pump to the top of the wetwell. The access frame shall provide a hook to attach the chain or cable when not in use. The lifting chain or cable shall be sized according to the pump weight.

H. Cable Mounting Bracket

1. A cable bracket shall be provided with strain reliefs that support and hold the float switch cables, power cables, etc. Continuous cables shall run from pumps and level controls to a control panel or junction box. No splices shall be made in the wiring. The bracket shall be fabricated from 316 stainless steel and attached to the access frame with 316 stainless steel fasteners. A dielectric spacer shall be installed when bolting to an aluminum access frame.

I. Access Frame and Hatch

1. A separate access frame assembly shall be supplied with a separate hinged hatch for removal of each pump. The frame assembly and door shall be aluminum with 316 stainless steel hinges and hardware. The aluminum hatch shall be raised tread plate to provide a skid-proof surface. As a safety precaution, each pump shall be provided with a separate hatch so as to limit access to the wetwell. The frame shall support the cable mounting bracket. A recessed handle shall be provided with each door, as well as a safety latch to hold the door in an open position. Each hath shall be sized in accordance with the pump manufacturer's requirements of its specific submersible pump.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine the pump to be sure all passages are clean and clear of obstruction and that the impeller rotates freely. Examine the pump mounting surface, and make certain that bolts are properly located. Correct any irregularities prior to installation.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the drawings. Installation shall include furnishing the required oil and grease or initial operation. See Section 01700 – Contract Closeout.

B. The Contractor shall submit a certification from the equipment manufacturer stating that the installation of the equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.03 TESTING

A. Pumps: After all pumps have been completely installed and working under the direction of the manufacturer, conduct in the presence of the Engineer tests necessary to indicate that pump operation conforms to these specifications. Field tests shall include all pumps under this section. Supply all water or wastewater, labor, equipment and incidentals required to complete the field tests.

B. If the pump performance does not meet these specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified.

C. Motors: The Contractor shall megger each motor winding before energizing the motor and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor.

D. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with the manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

3.04 MANUFACTURER'S REPRESENTATIVE

A. Provide the services of a qualified manufacturer's service representative for 2 days to inspect equipment and installation, perform required field tests, and provide operation and maintenance instructions to the plant operators. Refer to Section 11001Equipment, Basic Requirements.

3.05 TOOLS AND SPARE PARTS

A. One set of all special tools for each pump station required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys. See Section 01700 – Contractor Closeout.

TABLE 11304-1

RECLAIMED WATER RETURN PUMP STATION
PUMP OPERATING CONDITIONS AND DATA

Manufacturer: Hydromatic
Model: S8L Non-Clog, 1,150 RPM, 15-inch diameter impeller, 8" discharge, 4" Solids, 60 HP

PUMP CHARACTERISTICS (EACH PUMP)

DESCRIPTION	UNIT	DESIGN POINT	OTHER DESIGN POINTS
Quantity	Ea.	3	
Capacity	GPM	3,000	1,000, 2,000, 3,500
Total Dynamic Head	Feet	54	88.5, 74, 45
Shut Off Head at No Flow	Feet	116	
Minimum Size Solid Sphere Passed	Inches	4	
Motor Horsepower	HP	60	
Maximum Speed	RPM	1,150	
Minimum Pump Efficiency at Design Point	Percent	75	
Pump Outlet Diameter	Inches	8	
316 SS Guide Bar Diameter	Inches	2	
Depth of Wetwell	Feet	22.5	
Electric Power	Volts	460	
	Phase	3	
	Hertz	60	
Variable Frequency Drive	Yes		

TABLE 11304-2

WASTE BACKWASH PUMP STATION

Manufacturer: Hydromatic
Model: S4N, Non-Clog, 1,750 RPM 7.6875-Inch Diameter Impeller, 4” Discharge, 3” Solids, 10 HP

PUMP CHARACTERISTICS (EACH PUMP)

DESCRIPTION	UNIT	DESIGN POINT	OTHER DESIGN POINTS
Quantity	Ea.	2	
Capacity	GPM	200	100, 300, 400
Total Dynamic Head	Feet	50	57, 46, 41
Shut Off Head at No Flow	Feet	64	
Minimum Size Solid Sphere Passed	Inches	3	
Motor Horsepower	HP	10	
Maximum Speed	RPM	1,750	
Minimum Pump Efficiency at Design Point	Percent	55	
Pump Outlet Diameter	Inches	4	
316 SS Guide Bar Diameter	Inches	2	
Depth of Wetwell	Feet	9	
Electric Power	Volts	460	
	Phase	3	
	Hertz	60	
Single Speed Motor	Yes		

END OF SECTION

SECTION 11312

GRAVITY DISK FILTERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish, install and test three (3) gravity disk filters.

B. The filters shall have all stainless steel media disks that operate in pairs. The filtration flow pattern shall be from inside the disks to outside the disks with filtrate leaving the filter by gravity. The filter shall be fed by gravity or by pumping.

C. The contractor shall furnish all labor, materials, equipment and incidentals required for installation of the filter assembly. The filter itself will be a completely self-contained unit including the drive assembly, the wash water pump, bottom sediment discharge valve and electrical junction box with emergency stop push button. The filter will not require field component assembly.

D. All motors, pumps, and bearings shall be designed for continuous duty and long operating life in a high humidity atmosphere. All electric motors and pumps shall be TEFC, 480 volt/60 hertz, 3 phase.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 13 – Instrumentation and Controls

B. Section 15062 – Ductile Iron Pipe and Fittings

C. Division 16 – Electrical

D. Section 16150 – Motors

E. Section 16483 – Variable Frequency Drives

1.03 QUALITY ASSURANCE

A. The equipment manufacturer shall have no less than twenty-five (25) installations of the same or similar applications, including 10 in the State of Florida.

B. All the equipment specified under this Section shall be furnished by a single manufacturer (the Disk Filter

Equipment Manufacturer) fully experienced, reputable, and qualified in the manufacture of the equipment specified.

C. Available Manufacturers – Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work are limited to Nova Water Technologies, LLC, Tampa, Florida or Approved Equal.

D. All finish assembled equipment shall be factory wet-tested prior to delivery. Manufacturer shall provide a complete wet-testing report included within the final operations and maintenance manual. Wet testing report shall include recorded measurement of motor amp draws, wash pressure verification, testing of project specific control panel with project specific equipment, and photographs of finished assembled equipment during wet testing. Wet testing report shall have certification signature and date in which project equipment has been tested and is ready for delivery.

E. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of three (3) trips and four (4) days at the jobsite to inspect the Contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.

F. The equipment manufacturer shall reserve a minimum of one (1) day on site to work with the SCADA software programmer for verification of filter system operation and monitoring of signals by the SCADA system. This time will be scheduled after all equipment is installed and operational and all field wiring completed.

G. The equipment manufacturer shall have a service center and parts warehouse within 300 miles of the installation.

H. The equipment manufacturer shall provide on-site servicing of the installation once a month for the duration of the manufacturer's warranty. On-site servicing shall be conducted by factory trained technicians based within a one (1) hour drive from the installation location. Field service reports summarizing monthly on-site servicing shall be written for project documentation. Field service reports shall be chronologically sorted and delivered to the Owner at the conclusion of warranty duration.

1.04 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples

B. Submit manufacturer's Certificate of Compliance certifying compliance with the referenced specifications and standards.

C. Shop Drawing Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions, anchor bolt locations, and field connections.

2. Certified shop drawings and cut sheets showing compliance with the performance requirements of this specification.

3. Descriptive literature, bulletins, and catalogs of the equipment, including lubrication points.

4. Installation, operation, and start-up procedures, including lubrication requirements.

5. Complete motor data

6. Total weight of the equipment including the weight of the single largest item, both empty and operating full of water.

7. A complete bill of materials for all equipment with the O&M manual. No samples will be required.

8. A list of spare parts that are supplied with the project.

1.05 DELIVERY, STORAGE AND HANDLING

A. After hydrostatic or other factory tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

B. Each box or package shall be properly marked to show its net weight in addition to its contents.

C. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted.

E. The Contractor shall store and temporarily support equipment prior to installation in strict accordance with the Manufacturer's recommendations and instructions. Protect all exposed surfaces. Keep records of the storage parameters and the dates that storage procedures were performed. The Contractor shall be responsible for work, equipment, and materials until inspected, tested and finally accepted.

F. Store gear reducers and motors in buildings or trailers which have a concrete or wooden floor, a roof, and fully closed walls on all sides. Protect the equipment from being contaminated by dust, dirt, vibration and moisture.

G. Temporarily connect equipment with built in space heaters to a power source and keep heaters in operation. Rotate all shafts that have bearings on at least a monthly basis.

H. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations and shall be properly match-marked for ease of field erection. The units shall be erected and lubricated in strict accordance with the instructions of the Manufacturer's field engineer.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Submit operations and maintenance manuals for the equipment in compliance with the Contract documents, 30 days prior to shipment. Manuals shall include:

1. Name, address, and telephone number of the nearest competent service representative who can furnish parts and technical service.

2. Descriptive literature, including illustrations, covering the operational features of the equipment, specific for the particular installation, with all inapplicable information omitted or marked out.

3. Operating, maintenance and troubleshooting information.

4. Complete maintenance parts list.

5. Complete connection, interconnecting and assembly diagrams.

6. Approved Shop Drawings.

1.07 WARRANTY

A. Per General Condition Article 9, the Contractor shall provide a 3 year warranty from substantial completion. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, F.O.B. its factory, any part or parts returned to it which examination shall show to have failed under normal use and service by the user.

B. Warranties and guarantees by the suppliers of various components in lieu of single source responsibility by the manufacturer will not be accepted. The manufacturer shall be solely responsible for the warranty of the disk filters and all integral components.

PART 2 PRODUCTS

2.01 GENERAL

A. Each of three (3) disk filters shall be the Ultrascreen® Disk Filter Model UL1608CS as supplied by Nova Water Technologies, LLC. Tampa, Florida or approved equal. The unit shall be complete, factory tested and ready for operation. The filter will be a totally self-contained functional unit. Field wiring and field piping will be by the Contractor.

B. All materials used shall be new, high grade, with properties best suited for the working environment. All stainless steel shall be grade 304 minimum. All stainless steel filter mesh shall be precision grade woven, 316 stainless steel, minimum.

2.02 PERFORMANCE AND DESIGN PARAMETERS

A. The 3 disk filters together shall be capable of filtering water from the reclaimed water storage ponds, and shall be able to filter the water at the following flow rates:

Average Daily Flow:	7.50 MGD
Peak Hourly Flow:	15.0 MGD
Average Daily Backwash Reject:	≤ 1% of the Average Daily Flow

B. The filters shall operate continuously, always presenting new filtering media surfaces to the incoming flow at all times. Backwash shall be initiated when the differential level indicator reaches a preset limit.

2.03 FILTER TANK

A. The filter tank shall be constructed of all AISI Type 304 stainless steel and shall have a minimum thickness of 4 mm.

B. The tank shall be completely covered with light weight covers that allow easy access for maintenance and inspection. Covers shall have two handles per section and be made from all Type 304 stainless steel. The Cover retaining frame shall be manufactured from Type 304 Stainless Steel. Non-metallic material for cover fabrication shall not be acceptable.

2.04 DRIVE ASSEMBLY

A. The drive assembly shall be of the Chain & Sprocket type for energy efficiency, equipped with a maximum 3.0 HP adjustable speed motor SEW MOVIMOT or equal. Speed control shall be accomplished by an integral VFD offering local or remote RS-485 communications.

B. The drive manufacturer shall be ISO 9001 certified. The motor shall be of the "energy efficient" type with a minimum service factor of 1.1, F class insulation, capable of operation with a temperature rise of minus 20 to plus 40 degrees Celsius and with an IP 55 or higher rated enclosure.

C. The drive shall have an adjustable carrier frequency to 16 kHz for quiet operation, and shall provide overload, overvoltage, and phase failure as protective functions.

D. The drive motor shall be inverter duty rated and be Totally Enclosed Fan Cooled (TEFC) with a pressed-steel fan guard.

2.05 CENTER AXLE ASSEMBLY

A. The center axle on which the disks are mounted shall be made of AISI 304 stainless steel. The axle assembly, including the disks, is to be designed so it can be removed from the tank. All internal hardware is to be AISI 304 stainless steel.

2.06 FILTER DISK ASSEMBLIES

A. Each disk frame shall be constructed entirely of AISI Type 304 stainless steel. Non-metallic material for disk frame fabrication shall not be acceptable.

B. The mesh panel mounting shall allow panel replacement from outside the filter by a single plant operator. The filtration mesh shall be a Type 316 Stainless Steel wire weave with nominal 25 micron apertures. The use of non-metallic filtration mesh shall not be approved.

C There shall be simple shoulder seals at the edges of each disk and the wall of the filtrate zone. These seals shall be made of industrial grade EPDM rubber for long life.

D Each disk shall have a minimum filtration area of 22 square feet and shall be able to support a layer of biological accumulation. This disk filter model shall have 16 disks and a total filtration area of 352 square feet.

E. The effluent outlet for the filtered water shall be 20-inches in diameter. The outlet shall connect to the plant through isolation valves supplied by the contractor.

2.07 BACKWASH ASSEMBLY

A. The backwash piping integral to the filter shall be constructed of 2-inch diameter 304L stainless steel pipe, and shall include 14 flat-jet quick release nozzles per spray header. All hardware shall be 304 stainless steel. Each spray header shall deliver 16.2 gpm of spray water at 60 psi. Reclaimed water shall be used as spray water which shall be controlled by a slow-closing solenoid valve. The outlet from the wash water concentrate

collection trough shall be 3-inches diameter. The total wash water volume shall be approximately 116.5 GPM per disk filter unit on an intermittent basis based on backwash frequency.

B. Actuated Valve

1. Each filter shall come equipped with one (1) electrically actuated, 3.0 inch diameter valve for draining accumulated solids from the bottom of the influent well. The Electric actuator assembly shall include an electric motor, reduction gearing, valve stem, drive nut/bushing, position limit switches, mechanical overload torque switches, ductile iron gear case and automatic declutchable hand wheel.

2. Motor speed reduction shall be by means of a gear train consisting of hardened steel spur gears and self-locking worm and worm gear sets. The worm shall be heat treated alloy steel and shall have rolled or ground worm thread surfaces. The worm gear material shall be bronze. Non-metallic gears in the power train shall not be acceptable.

3. All gearing and shafting shall be supported on anti-friction bearings. All thrust components shall be supported by use of tapered roller bearings.

4. The actuator shall be furnished with a hand wheel located in a 90 degree plane from the actuator output drive, and designed to produce the specified torque with a maximum rim pull requirement of 60 pounds. An external manual declutch lever shall be included to place the actuator in the manual mode. The lever shall not require more than a 10 pound force to engage even when the valve has been tightly seated. The lever shall be padlockable in either hand wheel or motor mode. Operation by the motor shall not cause the hand wheel to rotate, and manual operation of the hand wheel shall not cause the motor to rotate. The hand wheel shall operate in the counter-clockwise direction to open, and in the clockwise direction to close.

5. All gearing and bearings shall be grease lubricated and suitable for year-round service based on prevailing ambient temperature conditions.

6. Electric motors shall be specifically designed for valve actuator service, and shall be totally enclosed, nonventilated. The enclosure shall meet NEMA 4 (weatherproof) requirements as required by the project. The motor shall be capable of operation under maximum specified loads when voltage to the motor is +/- 10% of the nominal voltage. Motor shall have Class F insulation with thermal overload sensors imbedded in the motor windings.

7. Limit switches shall be geared to the drive mechanism and shall indicate actual valve position at all times, whether operation is by electric power or manual mode. Limit Switches shall be activated by a rotor type design. Contacts shall be silver and have a rating of 10 amps at 120VAC. A minimum of (3) N.O. and (3) N.C. contacts shall be present to prevent entrance of foreign matter or wire entanglement. Use of cams or screws to set switches, or designs requiring battery back-up methods to ensure position control in the event of a power failure are unacceptable.

8. The actuator shall include an adjustable torque switch to interrupt the motor power circuit when an obstruction is encountered in either direction of travel or when torque seating of valves is required for tight shut off. The torque switch shall have a calibrated dial for adjustment, and shall have means to ensure that the maximum actuator rating is not exceeded. Contacts shall be same construction and rating as limit switches. Mechanical torque springs for load control shall be field replaceable without need of actuator dismantling or removal of the worm assembly.

2.08 FILTER INLET AND EFFLUENT VALVES

A. Each disk filter inlet pipe and effluent pipe shall require isolation valves in the yard piping. These valves shall be supplied and installed by the Contractor as part of the plant yard piping

2.09 LEVEL SENSING DEVICE

A. A set of (5) conductivity probes shall be used to operate the filter while in “AUTO” mode. Four (4) of the probes shall control the start/stop of the filter gear drive and backwash pump cycles. The fifth probe shall be used as a

high level (overflow) indicator. An overflow event shall energize a beacon light at the control panel and an audible alarm. A remote "dry" contact shall be available for alarm indication to plant SCADA.

2.10 CONTROLS

A. Each disk filter unit shall be supplied with a separate, local control panel in a NEMA 4X, Type 304 stainless steel enclosure. The control panel shall be UL listed and designed for outdoor use in corrosive environments. All operator components shall be mounted on a dead-front swing-out hinged inner door. Motor breakers and starters shall be NEMA type. The control panel shall include engraved, descriptive labels that are attached using permanent adhesive. The control panel shall be factory tested before installation on site. Field wiring shall be provided and installed by the Contractor. The control panel shall include, but not be limited to the following:

1. Circuit Breakers: main, control power, filter gear drive, backwash pump

2. Motor Starters: filter gear drive, backwash pump. Adjustable, solid state overloads are included.

3. Pilot Lights: "RUN", "OVERLOAD" and "FAIL" for gear drive and backwash pump; main power "ON"; "High Level Overflow", "Emergency Stop" depressed.

4. Pushbuttons: "Emergency Stop", "Alarm Silence", Motor Fail "RESET", Emergency Stop "RESET"

5. H-O-A selectors: filter gear drive, backwash pump, sludge discharge valve, plant wash water solenoid.

6. Elapsed Time Meters: filter gear drive and backwash pump

7. Dry Contacts for Plant SCADA: "OVERLOAD", "RUN", "FAIL" for filter gear drive and backwash pump, "HIGH LEVEL OVERFLOW" and "COMMON ALARM" for filter.

B. Each filter shall be supplied with an equipment mounted Emergency Stop/Junction box in a NEMA 4X, Type 304 stainless steel enclosure. The junction box shall be UL listed and designed for outdoor use in corrosive environments. The junction box shall include terminal

blocks for all filter mounted equipment such that the installing contractor will only have to run field wiring to one centralized location. The junction box shall also include a NEMA 4X, 30mm, mushroom head, Emergency Stop button located on the outer door of the enclosure.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the Disk Filters to be sure all passages and filter meshes are clean and clear of obstructions and that the disks rotate freely. Examine the disk filter unit mounting surface, and make certain that bolts are properly located. Correct any irregularities prior to installation.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the drawings. Installation shall include furnishing the required oil and grease for initial operation. See Section 01700 – Contractor Closeout.

B. The Contractor shall submit a certification from the equipment manufacturer stating that the installation of the equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.03 TESTING

A. After all disk filter units have been completely installed and working under the direction of the manufacturer, conduct in the presence of the Engineer tests necessary to indicate that disk filter operation conforms to these specifications. Field test shall include all three (3) disk filter units under this section. Supply all reclaimed water, labor, equipment and incidentals required to complete the field tests.

B. If the disk filter unit performance does not meet these specifications, corrective measures shall be taken, or the disk filter units shall be removed and replaced with disk filters which satisfy the conditions specified.

C. Motors: The Contractor shall megger each motor winding before energizing the motor and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor.

D. The Contractor shall check all motors for correct clearance and alignment and for correct lubrication in accordance with the manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

3.04 TOOLS AND SPARE PARTS

A. One set of all special tools for the disk filter units required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys. See Section 01700 – Contract Closeout.

END OF SECTON

SECTION 11348

SODIUM HYPOCHLORITE CHEMICAL FEED PUMP SYSTEM

PART 1 - GENERAL

1.01 SCOPE

A. Work under this section includes a complete sodium hypochlorite chemical feed system. The system shall consist of a feed system composed of chemical feed pumps, all necessary pump accessories, piping, valves and control panel installed on a polyethylene skid. All materials shall be provided in accordance with these specifications. See Table 11348-1 at the end of this Section for design data.

B. All components of the system shall be compatible with the conditions and chemicals to which they are subjected to during the normal operation of the system. Compounds with which the materials must be compatible include, but are not limited to:

1. 12-15% Sodium Hypochlorite

C. It is he intent of these Specifications that the Contractor is to provide a complete and workable system whether or not any specific component is shown or specified.

1.02 MANUFACTURER

A. All components of the feed system shall be provided by a single manufacturer who shall have sole-source responsibility for the system.

B. The manufacturer of this equipment shall be recognized and established in the design, production, and operation of chemical feed injection systems. The manufacturer shall provide, with the submittal data, a list of 10 similar systems in operation using chemicals associated with municipal wastewater. These systems must have been in operation at least five years. The list shall include correct names, phone numbers, and length of service and design criteria.

C. The manufacturer shall maintain regular production facilities at their place of business. These facilities shall be open for inspection by a representative of the Owner or Engineer at any time during construction and testing of this equipment.

D. The manufacturer of the feed system shall be an Underwriters Laboratories listed manufacturer of Enclosed Industrial Control Panels.

E. The system shall be provided by Grundfos/Alldos, Blue Planet Environmental Systems, or approved equal.

1.03 SUBMITTAL

A. The manufacturer shall submit complete shop drawings and engineering data to the Owner or Engineer in accordance with Specification 01340. These submittals shall include, at a minimum:

1. Drawings showing plan and elevation views of the feed system including fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall consist of, at a minimum, control schematics, including coordination with other electrical control devices operating in conjunction with the sodium hypochlorite feed system.

2. Manufacturer’s catalogue information on major system components including, but not limited to:

   a. Chemical Feed Pumps
   b. Pump Accessories
   c. Valves
   d. Control Panel

3. Statement of design conditions and performance guarantee

4. Statement of warranty

5. Reference list as described in section 1.02, B above

B. The manufacturer shall submit complete Operation and Maintenance manuals to the Owner. These manuals shall include at a minimum:

1. Information on hazards associated with the system and the appropriate safety

2. Equipment installation instructions

3. Equipment startup instructions

4. Equipment maintenance procedures

5. Troubleshooting guide

6. Individual operation and maintenance information on major system components, including but not limited to:
   a. Chemical Feed Pumps
   b. Pump Accessories

1.04 SUBSTITUTIONS

Any substitutions or deviations in equipment or arrangement from that shown on the drawings specified herein shall be the responsibility of the Manufacturer or Contractor. Any deviations must be accompanied by detailed structural, mechanical, electrical drawings and data for review by the Engineer. All costs associated with review of the substitutions or deviations and costs associated with project drawing changes as a result of approval shall be borne by the Manufacturer or Contractor. There shall be no additional costs to the Owner due to substitutions or deviations.

PART 2 - PRODUCTS

2.01 POLYETHYLENE DOSING SKID

A. Chemical Feed Pump Operation

1. The sodium hypochlorite feed system metering pumps shall operate automatically in response to the control signals as described in these Contract Documents.

2. A 4-20 ma chlorine residual signal and the reclaimed Water Return Pump Stations' discharge flow signals from 3 stations shall be used to control the chemical feed pumps. If a pump fails, the pump shall be manually/automatically switched over to the standby pump.

B. General. The Skid shall contain the following:

2 - Hydraulic Piston Diaphragm Chemical Feed Pumps
2 - Pulsation Dampeners
2 - Pressure Relief Valves
2 - Pressure Gages
2 - Back Pressure Valves
1 - Calibration Cylinder
1 - Control Panel

C. Standards. All fabrication and wiring shall conform to the standards of Underwriter's Laboratories, National Electrical Code, and any other applicable federal, state, or local codes.

D. Pump Accessories.

1. Calibration Cylinder. The skid shall be used to house a calibration cylinder used to measure the chemical being injected into the system.

2. Disconnect Switch. Each pump shall have a local disconnect switch on the control skid.

3. Pressure Relief Valve. The skid shall be equipped with 2 pressure relief valves, one for each pump. Each pressure relief valve shall be field adjustable from 0 – 150 psi via the adjustment screw.

4. Back Pressure Valve. The skid shall be equipped with 2 back pressure valves, one for each pump. The back pressure valve shall be field adjustable from 0 – 150 psi via the adjustment screw

5. Pulsation Dampener. The skid shall be equipped with a pulsation dampener on the discharge of each pump

6. Valves. All valves shall be true union type ball valves.

7. Diaphragm Protected Pressure Gauges

8. 2-1/2″ liquid filled pressure gauges with isolators shall be provided for indication of system pressure in the discharge piping of each metering pump. Industrial quality all 316 Stainless Steel gauges shall be utilized. The isolators shall have housings compatible with 12 to 15% sodium hypochlorite with a Teflon diaphragm and suitable liquid fill. The process connection shall feature a SS reinforcement ring not in contact with the chemical. A fabricated PVC bracket shall be provided for each pressure gauge to secure the isolator and prevent lateral movement of the pressure gauge.

E. Duplex Control Panel:

1) Each skid shall be supplied with its own control panel suitable for remote mounting.
2) Each pump shall have its own circuit breaker mounted in the control panel.
3) A common terminal strip shall be utilized for electrical connections at the control panel. Terminals shall be provided for a single control panel 120 volt, single phase power input.
4) All wiring on the skid shall be performed prior to shipping and shall terminate in a NEMA 4X junction box located on the skid. Terminals shall be provided in the junction box for all connections between the remote control panel and the junction box.
5) Each pump shall be provided with the following controls:

   a. Local HOA switch
   b. Start/Stop discrete input to skid
   c. Electronic motor speed controller capable of accepting remote 4 to 20 ma signals for automatic feed rate adjustments.
   d. Stroke length control: Manually adjustable from 0-100%.
   e. Alarm discrete output from skid

6) In addition to local start/stop, stroke and speed control, the pump shall include a selector switch to determine local operation or remote control. The pump shall be capable of accepting a remote start command from a discrete, dry contact input in addition to a 4-20 ma for speed control. Additional monitoring signals shall include a pump in remote control mode, pump run status, pump fail and a 4-20 ma dc signal for speed feedback.

F. Name Plates:

1) Each pump and motor shall be furnished with a suitable nameplate securely mounted to the body of the equipment.
2) As a minimum, the nameplate for the pumps shall include the following:

   a. Complete equipment model number.
   b. Manufacturer's name and address.

c. Serial number
d. Rated maximum flow capacity
e. Maximum discharge head
f. Horsepower
g. Speed
h. Armature voltage
i. Armature amps
j. Field voltage
k. Field amps
l. Power and service factors.

2.02 CHEMICAL DOSING PUMPS

A. Provide two chemical metering pumps on one skid. Each pump shall be completely compatible with 12-15% sodium hypochlorite. Each pump shall be capable of delivering a maximum of 128 gph at a maximum pressure of 145 psi. Pump shall have a 100:1 turndown. Chemical dosing pumps shall be the hydraulic piston diaphragm type. The pump shall be constructed from corrosion resistant materials. The pump shall be a Grundfos/Alldos Series KM250, Model 255-403.

B. Each of the chemical feed pumps shall be of the hydraulic piston diaphragm type, wherein a volume measuring piston reciprocates within a cylinder and causes hydraulic oil to deflect a flat diaphragm, which in turn causes the head to pump the chemical. Each pair of chemical feed pumps shall have compatible materials and be designed to pump 12 to 15% sodium hypochlorite.

C. The pump shall be able to withstand closed suction or discharge valves without damage to the internals of the pump.

D. Pumps shall be mechanical lost motion type flow control where a cam driven by the worm gear actuates a reciprocating piston to drive the hydraulically actuated diaphragm.

E. The pump shall include a diaphragm control package, which shall signal an alarm for a broken diaphragm or an over pressure situation. Each pump shall be equipped with a PTFE double diaphragm and a ball check valve with an integrated contact pressure gauge that can sense an emergency pressure situation.

F. Each pump shall be provided with English process pipe connections.

G. The metered liquid will enter the reagent head at the bottom and exit at the top through gravity seating ball-type valves. These three-component valves shall be free-seating type with valve seats having knife edge contact and will be 4-point guided to accurately control vertical and sideward movement. Valve and seat shall be individually replaceable and sealed by o-ring or flat gasket. Valve assemblies shall not incorporate any threading other than the process pipe connections. Valves shall be serviceable without removing piping.

H. The chemical metering head shall be designed to resist connection forces and help promote leak-free performance.

I. The diaphragm shall be a full teflon design. The diaphragm shall be capable of sealing under full head-bolt torque limits without stressing the diaphragm. Manual capacity adjustment by changing the position of the control slider from 0-100% shall be accomplished while idle or operating. An auto-lock system for the manual (handwheel) slider position control mechanism shall be provided, as standard, to prevent drift. The large handwheel shall be pressed down and shall provide detented indication of slider position adjustment with resolution of $\pm$ 1/2%.

J. The pump shall incorporate a non-vented gear box and eccentric designs to protect the pump from the ingress of water, dirt, sand or other debris. A rotary type lip seal arrangement shall positively seal and separate the two oils of the gear box and the eccentric box. The gear box shall be filled with a heavy duty gear oil and the eccentric box shall be filled with a hydraulic oil to provide the best environment of operation for the hydraulic system.

K. The eccentric shaft shall be supported by ball bearings for long life. The eccentric shaft shall be a non-axially loaded, one piece design. The main input speed reduction shall be accomplished via a precision cut gear and hardened steel worm shaft.

L. The pump shall be provided with a C-face motor, able to be mounted in a vertical position. The C-face motor mounting

arrangement shall eliminate the exposure to rotating couplings. Coupling enclosure shall be totally enclosed and part of the motor mounting assembly. The motor shall be capable of operating in a clockwise or counterclockwise direction without impact on pump performance or components.

M. Pump design shall be modular type to allow for easy access to, and interchangeability of, assemblies or components. The gear reduction unit shall be capable of being mounted on either side of eccentric box.

N. Flow adjustment shall be from 0-100% with a guaranteed accuracy of ± ½% steady state on set points over a 10:1 flow turndown range.

O. Each pump shall be capable of pumping with a net positive suction head available as low as 3 psi.

P. Variable Speed Drives

1. The Chemical Feed Pumps shall utilize variable speed motors and automated slider position adjustment to provide the necessary automated pacing of the chemical feed pumps using 4 to 20 ma signals from the plant SCADA system. Variable speed drives and motors shall utilize 460 VAC - 3 phase power. Each variable speed drive shall be capable of variation of pump speed in proportion to a 4-20 ma input signal. Each variable drive shall be capable of producing an output signal of 4-20 ma in proportion to actual speed. Each variable drive shall be capable of operating from a manual potentiometer when this option is manually selected. Each variable drive shall be able to start or stop the motor in response to an external signal. Each variable drive shall produce dry contact outputs to indicate motor running or drive FAULTED.

2. Chemical feed pump motors shall be designed to provide the proper variability and operating performance as required for correct operation of the metering pumps. Motors shall be specially designed to operate in a variable speed mode using the VFD specified. Motors shall be Inverter Duty. Motor insulation requirement shall meet or exceed the requirements of MG1 –

1998, Part 31, Section 4, requiring operation at 1600 V peak to peak, with a .1 micro-second rise time. The operating speed range shall be 10 to 1. Motors shall be as manufactured by Reliance, Baldor, US Motors, or approved equal.

3. The feed pump supplier shall coordinate the control requirements with the Contractor so that the feed pump power and control configuration is appropriate and complete. The detailed wiring shall also include all of the various protection features which may be provided with the feed pumps, in accordance with the recommendations of the pump manufacturer. Refer to section 13300 for further details.

Q. Materials

1. Reagent Head – PVC

2. Seals – Viton

3. Check Valve Balls – Glass

4. Diaphragms - Teflon

PART 3 - EXECUTION

3.01 SITE AND UTILITIES

The feed system shall be located as shown in the plans. The following utilities shall be provided at the feed system site and located as shown on the drawing. Site preparation and utility services shall be provided by the Contractor, not by the chemical feed pump skid Manufacturer.

A. Electrical. 480 VAC, 3-phase, 60 Hertz power shall be provided to the control panels.

B. Drain - A minimum 2-inch P.V.C. gravity pad drain to sewer is recommended.

C. Concrete Foundation

D. All trenching excavation and backfill.

3.02 EQUIPMENT SHOP TESTING

Before shipping the equipment, the Manufacturer shall perform shop tests. These tests shall include at a minimum:

A. Visual inspection of all equipment.

B. Complete assembly, start-up, and “wet-test” of feed pumps and calibration piping.

3.03 INSTALLATION

The system shall be installed in accordance with the manufacturer’s instructions. All installation personnel shall be trained and qualified in the areas of plumbing, electrical work, and instrumentation as required to complete the installation.

3.04 FIELD TESTS

A. The performance of the system shall be demonstrated to dose the specified amounts of sodium hypochlorite.

B. If required, Manufacturer shall make any changes to the system, at his own expense, that may be necessary to assure satisfactory and efficient operation of this system.

3.05 WARRANTY

The Manufacturer shall guarantee that the Chemical Feed system will perform as described in these Specifications. The Manufacturer shall warrant the system, complete, to be free from defects in materials or workmanship for a period twelve (12) months from acceptance or eighteen (18) months from shipment, whichever occurs first. The metering pumps shall be warranted for three (3) years from acceptance by the Manufacturer. The Manufacturer shall repair or provide replacement for any defective components under this warranty.

TABLE 11348-1
CHEMICAL METERING PUMP SCHEDULE
SWWRF Disk Filter and North Pond Improvements

NWRF EXPANSION PHASE I	
Pump Numbers	5 and 6
Location	Chlorine Building
# Pumps	2
Chemical	12-15% NaOCl
Type Pump	Positive Displacement Hydraulically Actuated Diaphragm
Max. Horsepower	0.50
Controls	Local Control Panel 2.0
Slider Position Control	4-20 ma
Stroke Rate Control	4-20 ma
Design Max. Capacity-GPH	128
Max. Pressure-psi	145
Piping Material	SCH 80 PVC
Type Ball Valves	TYPE 21 PVC (Vented)
Skid Piping Outputs	2
Manufacturer	Grundfos/Alldos
Model No.	255-403

END OF SECTION

SECTION 13300

INSTRUMENTATION AND CONTROLS, GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 THE REQUIREMENT:

A. The Contractor shall provide, through the services of a single Control System Integrator (CSI), all components and system installation services, as well as all required and specified ancillary services, whether reflected in the Contract Documents or not, in connection with the Instrumentation and Control System (ICS) as specified herein for a complete and operable system. The system shall include all materials, labor, tools, fees and documentation required to furnish, install, test and place into operation, a complete and operable ICS whether or not shown and/or specified within this section, related ICS specification sections, and subsections within equipment specifications. The system shall include all measuring elements, signal converters, transmitters, specialty cables, control panels, digital hardware and software, remote telemetry units (RTU), signal and data transmission systems, interconnecting wiring and such accessories as shown, specified and/or required to provide the functions indicated, whether specifically mentioned or not.

B. The requirements provided within this section shall be applied to all of the Instrumentation and Controls specifications, Sections 13300 through 13330, as well as additional specifications sections as referenced. The ICS shall be provided as a single and complete system as specified herein and as specified within the following ICS specifications:

1. Section 13310 - Instrumentation and Controls, Field Equipment
2. Section 13320 - Instrumentation and Controls, Control Enclosures
3. Section 13330 - Instrumentation and Controls, SCADA Hardware

C. For the purposes of these specifications the Control System Integrator shall be referred to as the CSI. Where references are made to the SCADA System Programmer or the SSP, it shall be understood that

CSI will not be providing that work under this Contract. Although the SSP will provide programming services outside of this Contract, that in no way relieves the CSI from providing all materials, labor, documentation, etc., including coordination, programming, startup, and testing services as necessary to ensure the complete system is fully capable of providing all specified functions, whether provided by the CSI or programmed by the SSP. Additional clarifications of responsibilities are provided herein and within related ICS specifications, as it pertains to the relationship between the CSI and the SSP.

D. The Contractor shall be ultimately responsible for installation of the ICS. However, the CSI will include installation within the scope of the subcontract to provide for furnishing and installation of the complete system as specified. The CSI shall also coordinate this work with the Contractor to ensure that the proper type, size and number of wires with their conduits are provided and installed. This coordination will also ensure that proper electrical power circuits are provided for all components and systems.

E. The Contractor’s responsibilities, as distinct from the CSI’s responsibilities, shall be to provide all additional materials and work necessary to supplement the materials and work provided by the CSI, thereby satisfying all requirements that are within ICS specification sections.

F. The Contractor shall coordinate structural work, penetrations, painting, etc., as required for installation of a complete ICS. In-line or integrally mounted items (such as flow elements, level sensors, etc.) shall be installed under the supervision of the CSI.

G. The Contractor shall be responsible for coordinating interfaces between ICS equipment provided under the ICS specification sections and the equipment provided under other sections of the specifications. The Contractor shall verify and coordinate space requirements, process equipment power supply and voltage, process equipment control power supply and voltage, compatibility of control signals, details of equipment installation and interconnection. Coordination shall include distribution of approved

shop drawings to all vendors, subcontractors, etc., involved in the control interface. Likewise, the Contractor shall ensure that instrumentation and control devices provided under other sections of the specifications are compatible and of the same quality and characteristics as similar devices specified under the ICS specification sections.

H. The CSI will not be responsible for providing PLC and HMI control programming and logic. These services will be provided under a separate contract.

1.02 SCOPE:

A. The scope listed within this subsection pertains to major items of supply. Refer to the complete Contract Documents for all requirements. For additional clarification of scope refer to related specification sections.

B. This project shall provide for the expansion and upgrade of the Manatee County Southwest Water Reclamation Facility. This project will include and provide additions, upgrades and modifications to the in-plant SCADA System and existing ICS. The ICS shall monitor and control the new Lake Filter and Backwash Pumping System, Reclaimed Storage Pond Return Pumping System, the Reclaimed/Reject Water Quality Control, the Sodium Hypochlorite Metering Pump Modifications and all other systems, facilities and components as shown on the Drawings and Technical Specifications.

C. Monitoring and control shall be through PLC control panels communicating over a fiber optic Ethernet network to the Human-Machine Interface (HMI) operator interface located in the facility control room. Network communications shall consist of fiber cables, patch panels, patch cables (fiber and hard-wired), fiber optic switches, etc. as required and specified to provide a complete system.

D. Modifications will be required in existing PLC control panels SP-1 (Electrical Building) and SP-2 (Chemical Building) to accommodate the new Input/Output signal requirements and communications infrastructure.

E. Modifications will also be required in the existing North Pond Pump Control Panel and PLC control panel

(SP-12) for the addition of one (1) pump to the existing controls. Note: The North Pond Pump Station will be converted to the North Pond Reject Return Pump Station as part of this project and is referenced herein accordingly.

F. New SCADA PLC panels will be provided at the Lake Gravity Disk Filter (SP-15) and North Reclaimed Return Pump Station (SP-14) area to accommodate the I/O requirements for the equipment in this area.

G. The following additional major items of supply shall be provided:

1. Furnish and install instrumentation as specified.
2. Furnish TVSS for instrumentation and control panels as specified.
3. Furnish and install new equipment to provide all specified SCADA Input/Output signals and functions.
4. Furnish and install all Control Panels as scheduled (Lake Filter system control panels are provided by the manufacturer under this project).
5. Provide, install and configure all SCADA software packages specified and as needed to complete the requirements noted herein.
6. Interface with control panels provided by other equipment suppliers under this contract.
7. Spare parts as described herein.
8. Implementation and testing of the complete system, including testing with the SSP.
9. Training of Owner personnel.
10. Operations and Maintenance Manuals.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Division 11 - Equipment

1. Refer to individual product specifications within specification sections for additional requirements specific to those devices. Instrumentation and control equipment

supplied as part of packaged systems shall be integrated into the ICS as specified.

2. Where Division 11 equipment suppliers are providing instrumentation and control equipment for which there is no specification within their respective equipment specification, they shall provide equipment in accordance with the ICS specifications. This equipment shall be compatible and of the same quality and characteristics as similar devices specified under the ICS specifications. If possible the same make and/or model supplied under the ICS specifications shall be provided.

3. PLC and HMI programming performed by Division 11 equipment suppliers shall be coordinated with the CSI to provide supervisory control and monitoring of control panels provided under Division 11 via network communications.

B. Division 16 - Electrical

1. Where electrical subcomponents are to be provided as part of ICS equipment, but for which there is no specification, provide in accordance with Division 16 - Electrical. These subcomponents shall be compatible and of the same quality and characteristics as similar devices specified under Division 16 - Electrical. If possible the same make and/or model supplied under Division 16 shall be provided.

2. The following work shall be provided under Division 16 - Electrical:

   a) Conduit, raceways and installation of wire and cable for all instrumentation and control system signal wiring, grounding systems, special cables and network cables except as noted.

   b) Instrumentation and control system signal field wire.

   c) Final wire preparation and termination of field wires to ICS equipment as directed by the CSI.

   d) Grounding systems for all ICS equipment.

e) Mounting of ICS electrical enclosures (i.e. control panels, TVSS boxes, electronic instrumentation, etc.) with exclusion of final measuring elements of instrumentation (i.e. flow tubes, sensors in process piping, etc.) which shall be as coordinated by the Contractor.

3. The CSI shall provide all termination information for the ICS equipment, to support equipment terminations provided under Division 16. This information shall be provided within ten (10) days of ICS equipment arrival onsite or as required by the project schedule. The information shall be in the form of drawings and termination lists, showing complete termination information (to/from panels, terminal numbers, terminal block locations, signal types, voltages, etc.).

1.04 CODES AND STANDARDS:

A. The ICS shall comply with the National Electric Code, National Electric Safety Code, OSHA and with all applicable federal, state, county, municipal and electrical utility codes and regulations, as well as the Contract Documents. In the event of any conflict between these codes, regulations and Contract Documents, the most restrictive shall apply.

B. The Instrumentation and Control System shall comply with the following codes and standards as well as any others within the specifications and drawings. In the event of any conflict between these codes, regulations, standards and Contract Documents, the most restrictive shall apply.

1. Applicable state, county and municipal code requirements.

2. Applicable standards of the National Fire Protection Association (NFPA)

a) National Electrical Code (NEC).

3. Applicable standards of the Underwriter's Laboratories, Inc. (U.L.)

a) UL 508 Industrial Control Equipment

b) UL 508A Industrial Control Panels

c) UL 698 Industrial Control Equipment for Use in Hazardous Locations

4. Applicable standards of the Institute of Electrical and Electronics Engineers (IEEE)

5. Applicable standards of the National Electrical Manufacturers Association (NEMA)

a) NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum)

b) NEMA ICS 1 Industrial Control and Systems: General Requirements

c) NEMA ICS 6 Enclosures for Industrial Control and Systems

6. Applicable standards of the International Society of Automation (ISA)

a) S5.1 Instrumentation Symbols and Identification

b) S5.4 Instrument Loop Diagrams

c) S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves

d) TR20.00.01 Specification Forms for Process Measurement and Control Instruments

1.05 SUBMITTALS:

A. All shop drawings shall be in accordance with Section 01340 – Shop Drawings, Project Data and Samples. In addition to the requirements set forth in Section 01340 – Shop Drawings, Project Data and Samples, the following additional submittal requirements included herein shall apply.

B. Every submittal shall have a separate section entitled "Requested Deviations from ICS Specifications" which shall clearly define and explain all requested deviations and exceptions of the Instrumentation and Control System to this Specification. Only those deviations requests listed in this section will be reviewed by the Engineer.

C. After all changes or corrections resulting from the Engineer's review of the system supplier's drawings have been made, panels may be built and instrumentation devices may be supplied in accordance with the approved drawings. One set of 'As Shipped' prints shall be included in the panels when shipped from the system supplier's wiring and assembly shop.

D. The following major list of submittals shall be provided as a minimum. Major submittals are generally listed in the order they are to be provided. Refer to related ICS specification sections and equipment subsections for additional submittals and submittal requirements.

1. Preliminary Design Review/Project Plan
2. Process Field Instrumentation
3. SCADA System Control Panel Modifications
4. SCADA System Hardware and Software
5. Preliminary Operation and Maintenance Manuals
6. Training
7. Testing Submittal
8. Tools, Supplies and Spare Parts
9. Site Installation/Startup Plan
10. Final Operation and Maintenance Manuals

E. Preliminary Design Review/Project Plan Submittal

1. The Project Plan shall provide an overview of the proposed system including system architecture diagrams, the approach to work, the proposed work schedule indicating milestones and potential meetings, project personnel and organization, details of factory testing and field testing, details of training programs, and a paragraph by paragraph review of the specifications indicating any proposed deviations. The schedule shall illustrate all major project milestones including the following:

   a) Schedule for all subsequent project submittals.

   b) Tentative dates for all project design review meetings.

c) Schedule of manufacture and staging of all instrumentation and control system equipment.

d) Schedule for all testing.

e) Schedule for shipment of all instrumentation and control system equipment and peripheral devices.

f) Schedule for equipment start up.

g) Schedule for all training.

2. The Project Plan submittal will be followed by an ICS project kickoff meeting which will be a discussion of the Project Plan Submittal concerns and issues. This meeting will be scheduled a minimum of two weeks following delivery of the submittal. No other submittals will be allowed prior to acceptance of the Project Plan.

F. Process Field Instrumentation Submittal

1. This submittal shall provide complete documentation of all field instruments and other instrument and control equipment not specified to be submitted elsewhere.

a) Provide data sheets for each component listing all model numbers, optional and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

1) Plant Equipment Number and ISA tag number per the Loop Diagrams.

2) Product (item) name used herein and on the Contract Drawings.

3) Manufacturer's complete model number.

4) Location of the device.

5) Input - output characteristics.

6) Range, size and graduations.

7) Physical size with dimensions, enclosure NEMA classification and mounting details.

8) Materials of construction of all components.

9) Instrument or control device sizing calculations where applicable.

10) Certified calibration data on all flow metering devices.

b) Provide equipment specification sheets which shall fully describe the device including the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:

1) Dimension, rigid clearances.

2) Mounting or installation details.

3) Connection.

4) Electrical power or air requirements.

5) Materials of construction.

6) Environmental characteristics.

7) Performance characteristics.

c) The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

G. SCADA System Control Panel Modifications Submittal

1. This submittal shall provide complete documentation of the proposed hardware (control panels, PLCs, peripherals, etc.) including:

a) A complete system block diagram(s) showing in schematic form, the interconnections between major hardware components such as:

control centers, panels, power supplies, consoles, computer and peripheral devices, telemetry equipment, local digital processors and like equipment. The block diagram shall reflect the total integration of all digital devices in the system and shall reflect any man/machine interface locations. All components shall be clearly identified with appropriate cross references to the location of each.

The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.

b) Data sheets for each hardware component, listing all model numbers, optional, auxiliary and ancillary devices that are being provided.

The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

1) Equipment Number and ISA tag number per the Loop Diagrams (as applicable).
2) Product (item) name used herein and on the Contract Drawings.
3) Manufacturer's complete model number.
4) Location of the device.
5) Input - output characteristics.
6) Range, size and graduations.
7) Physical size with dimensions, enclosure NEMA classification and mounting details.
8) Materials of construction of all components.
9) Power supply device sizing calculations where applicable.

c) Equipment specification sheets shall fully describe the device, the intended function, how it operates and its physical environmental and performance

characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:

1) Dimensions and working clearances.
2) Mounting or installation details.
3) Connection diagrams.
4) Electrical power requirements (volts, amps).
5) Materials of construction.
6) Environmental characteristics.
7) Performance characteristics.

d) Provide detailed loop diagrams on a single 11-in x 17-in or 8.5-In x 11-in sheet for each monitoring or control loop. The loop diagram shall show all analog, digital and discrete components of the loop, including all relays, switches, dropping resistors, etc. which are being provided for proper operation. Loop numbers used shall correspond to the loop numbers indicated in the Contract Documents. The format shall be the International Society of Automation, Standard for Instrument Loop Diagrams, ISA-S5.4 plus the following requirements:

1) On each diagram, present a tabular summary of (1) the output capability of the transmitting instrument, (2) the input impedance of each receiving instrument, (3) an estimate of the loop wiring impedance based on wire sizes and approximate length used, (4) the total loop impedance, (5) reserve output capacity.
2) Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels

(e.g. terminal junction boxes). The diagrams shall be coordinated with the electrical contractor and shall bear his mark showing this has been done.

3) Show location of all devices.

4) Show instrument description including type, manufacturer, model number, range, set points and operation (e.g. fail open, open on energization, normally closed, etc.) as applicable.

5) Show all instrument loop power or instrument air requirements back to termination on terminal block or bulkhead, fuse block (including fuse size), etc., as applicable.

e) Provide detailed drawings covering control panel consoles and/or enclosures which shall include:

1) Cabinet assembly and layout drawings to scale. These shall include both front, rear (where applicable) and interior layouts.

2) Material, fabrication and painting specifications.

3) Color selection samples for selection by the Engineer.

4) Where graphic display panels are required, submit detailed layout to scale, including symbols and line widths, as well as color selection samples and details of fabrication. Half-scale layout will be acceptable.

5) Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder format and shall reference the appropriate loop drawing for continuations or details where required. Show all wire numbers and terminal block designations.

f) The SCADA submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

H. SCADA System Hardware and Software Submittal

1. Software submittals shall include the following as a minimum:

a) Bill of materials with hardware components, software names, vendors and complete listings of included software modules.

b) Standard manufacturer's literature describing the products.

c) Description of function of software in ICS System.

d) Software features, limitations and constraints of software.

e) Minimum system (processor and memory) requirements.

2. Submit information on the following software, where applicable:

a) Operator Interface (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).

b) Control software (block oriented and/or ladder logic).

c) Office-type products, such as spreadsheets, word processors, etc.

d) Database management software.

e) Communications software, including all applicable local and wide area network software.

f) Programmable logic controller programming software.

g) Software configuration, including:

1) Graphic display organization.

2) Database configuration for real-time, historical, etc. databases.

3) Trends.

4) System security.

5) Formats for all reports, including all required calculations.

6) Intercommunications between software products required to implement system functions.

7) Equipment backup configuration and requirements.

I. Training Submittals

1. Training Plan Submittal: The training plan shall include:

a) Definitions of each course with necessary pre-requisites.

b) Specific course attendance.

c) Schedule of training courses including dates, duration and locations of each class.

d) Résumés of the instructors who will actually conduct the training.

J. Testing Submittals

1. Three levels of system testing shall be required: Unwitnessed Factory Testing, Operational Readiness Testing and Performance Acceptance Testing.

2. Test plans shall be submitted only after all hardware submittals have been approved by the Owner and/or Engineer.

3. The test plan shall demonstrate that the CSI has designed and configured a system that meets the design specifications. The documents for the test plan shall be structured so that the Owner understands what the inputs are, what the predicted outputs should be, and what the actual

outputs are. The test plan should have sign-off and date block for the CSI, the Contractor and the Owner.

4. The complete test plan should include but not be limited to the following:

   a) Test assumptions and methods

   b) Test Equipment List

   c) Test Personnel Staffing and Qualifications

   d) Test Schedule with time allotted for each task

   e) System hardware and software summary.

   f) Communications test to the various PLCs for Discrete and Analog I/O data transfer.

   g) One hundred percent (100%) I/O point test including all spare points based upon the previously submitted System I/O list.

   h) Functional and Control strategy tests.

5. Test Procedures: Submit the procedures proposed to be followed during the test. Procedures shall include test descriptions, forms and checklists to be used to control and document the required tests. Testing may not be started until all Testing Submittals have been approved.

6. Test Documentation: Submit a copy of the signed off test procedures upon completion of each required test.

K. Tools, Supplies and Spare Parts Lists Submittal

1. This submittal shall include a list of all required and recommended spares. The following information shall be provided in table format:

   a) Specification Section

   b) Tagname

   c) Description

   d) Quantity

   e) Manufacturer

   f) Model, part, order number

g) Local distributor and manufacturer contact information. Contact information shall include address, phone number and website.

L. Operation and Maintenance Manuals

1. Prior to installation of any equipment onsite, preliminary O&M manuals shall have been submitted and approved. No installation of equipment shall be permitted without the Contractor maintaining an updated version of these preliminary O&M manuals onsite for the Owner’s and Engineer’s use.

2. After all field changes or corrections made during installation and field check out have been completed, all system supplier documentation, including drawings, shall be revised to reflect the “as installed, corrected and accepted" condition of the system and final record copies of O&M manuals for the system shall be provided to the Owner and Engineer for approval.

3. Final system documentation shall be provided in 3-hole type binders of archival quality (e.g. slant D or elliptical binding, vinyl with metal hinge or extra heavy weight vinyl, etc.) with a binding no larger than 3”. Materials shall be printed on 8.5” x 11” or 11” x 17” tear resistant paper or ring reinforced paper where tear resistant is not available. Drawings shall be either folded to fit within an 8.5” x 11” binder or in an 11” x 17” 3-hole binder. Each binder shall include fifteen percent (15%) spare space for the addition of future material. Tear resistant paper shall be Xerox Never Tear or equal.

4. Where electronic documentation is available, either by purchase through the manufacture or via Internet download, it shall be organized and provided on CD. All CAD drawings and word processing documents prepared by the CSI or one of their subcontractors shall be organized and provided on CD. Electronic documentation formats shall be Adobe PDF, AutoCAD, Microsoft Office documents, HTML, or as approved by the Engineer or Owner.

5. All electronic media (i.e. software, electronic documentation, configuration files/reports, device backups, etc.) shall be provided with two (2) backup copies, each organized into a separate binder. Media storage binders shall include but not be limited to the following:

   a) Table of contents

   b) Archival media holders (e.g. CD, DVD, floppy, tape disk, etc.)

   c) Support contacts (i.e. company, phone, internet link, etc.)

   d) Software system requirements and installation instructions

6. Laminated water/tear resistant copies of all applicable instrumentation and control system drawings shall be supplied in drawing pocket of each control enclosure after “as installed, corrected, and accepted" revisions have been made to the enclosure.

7. Operation and Maintenance manuals shall include but not be limited to the following:

   a) Manufacturer standard O&M manuals for all equipment and software furnished.

   b) Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

   c) The manuals shall contain all illustrations, detailed drawings, wiring diagrams and instructions necessary for installing, operating and maintaining the equipment.

   d) All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable.

   e) A functional description of the entire system, with references to drawings and instructions.

f) A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

g) A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

h) Full specifications on each item.

i) Detailed service, maintenance and operation instructions for each item supplied.

j) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

k) Complete parts lists with stock numbers and name, address and telephone number of the local supplier.

l) References to manufacturers' standard literature where applicable.

m) Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

n) The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

o) The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

1.06 MEETINGS:

A. The Contractor shall be required to give the Owner, the Engineer and their representatives, at least three (3) weeks notice prior to any scheduled meetings. The notice may be shortened with Owner's and Engineer's consent.

B. Preliminary Design Review Meeting: A preliminary design review meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure design compliance, installation strategies and proper coordination between responsible subcontractors related to the ICS. The Contractor shall be responsible for arranging the on-site meeting no later than sixty (60) days after notice to proceed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved and distributed to meeting attendees. Two (2) weeks prior to the meeting the Contractor shall submit the following for approval:

1. A proposed list of meeting attendees including organization and phone number.
2. A proposed meeting agenda.
3. A list of personnel to be involved in the project including their responsibilities, qualifications and phone numbers.
4. An overall system description.
5. An overall system block diagram.
6. A description of all numbering, lettering, color and format conventions that will be used including examples of loop drawings, interconnection diagrams, schematic diagrams, documentation table of contents, etc.
7. A project schedule and implementation plan that coordinates the ICS installation with the installation of the entire site project.

C. Preliminary Site Testing Meeting: A preliminary site testing meeting shall be conducted by the Contractor for the Owner and Engineer, to ensure site readiness, testing strategies and proper coordination between parties related or involved in testing the ICS. The Contractor shall be responsible for arranging the on-site meeting after

the Site Testing Plan has been approved and no earlier than three (3) weeks prior to testing. The Engineer must be satisfied that the site is ready and that the testing will be performed to their satisfaction prior to any documented ICS testing being performed. The Contractor shall arrange for detailed meeting minutes to be recorded, approved and distributed to meeting attendees. Additional meetings may be required at the discretion of the Owner and Engineer to resolve specific action items not addressed in the preliminary site testing meeting. Two (2) weeks prior to the meeting the Contractor shall submit the following for approval:

1. A proposed list of meeting attendees including organization and phone number.
2. A proposed meeting agenda.
3. A list of personnel to be involved in the testing including their responsibilities, qualifications and phone numbers.
4. A list of tasks requiring Owner, Engineer or outside party involvement in testing.
5. A testing schedule that coordinates the ICS testing with the operability of the specific equipment being tested.

D. Additional meetings may be required at the discretion of the Owner and Engineer, to resolve specific action items not addressed in the preliminary design review or preliminary site testing meeting.

1.07 CONTROL SYSTEM INTEGRATOR:

A. The Control System Integrator shall be regularly engaged in the detailed design, fabrication, installation and startup of instrumentation and control systems for water and wastewater treatment facilities in the state of Florida. Any CSI that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five (5) calendar years shall not be acceptable.

B. Where specific manufacturers and/or models of major hardware or software products (PLC, software, network equipment, wireless equipment, etc.) are specified to be used on this project, the CSI shall have completed

at least one (1) project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.

C. Control System Integrators shall meet the following minimum qualifications:

1. A minimum of seven (7) years experience with at least five (5) years in water / wastewater projects
2. References for three (3) completed projects of like size and application to the project specified herein
3. Project bonding capacity of two million dollars ($2,000,000)
4. UL 508 certified control panel manufacturing shop
5. On staff licensed professional engineer registered in the state of Florida, if required to perform engineering services as specified to implement this project.

D. The listing of acceptable Control System Integrators in this specification in no way relieves the Control System Integrator from meeting the qualifications specified herein. Acceptable Control System Integrators shall be as follows:

1. Revere Control Systems: 2240 Rocky Ridge Road, Birmingham, AL, 35216; (205) 824-0004; www.reverecontrol.com
2. Curry Controls Company: 1019 Pipkin Road, Lakeland, FL 33811, (863) 646-5781; www.currycontrols.com
3. Commerce Controls: 9216 Hollyridge Place, Tampa, Fl 33637, (941) 301-9991; www.commercecontrols.com
4. DCR Engineering: 502 CR 640 E.; Mulberry, FL 33860, (863) 428-8080; www.dcreng.com
5. Rocha Controls: 5025 Rio Vista Ave; Tampa, Florida 33634; (813) 628-5584; www.rochacontrols.com

6. Commerce Controls: 9216 Hollyridge Pl., Tampa, FL 33637, 941-301-9991; www.commercecontrols.com

E. The Owner shall have the right of access to the CSI's facilities and the facilities of their equipment suppliers to inspect materials and parts, to witness inspections, tests and work in progress, and to examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The CSI and their equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

1.08 QUALITY ASSURANCE:

A. The listing of specific products in this specification in no way relieves the Contractor of furnishing equipment which shall meet the performance and quality criteria specified herein.

B. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.

C. For uniformity, only one (1) manufacturer will be accepted for each type of product.

D. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation and erection as well as during continuous or intermittent operation. Equipment shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

E. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble free service.

F. Electronic equipment shall be suitable for the specified environmental conditions.

G. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these specifications and drawings, shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.09 DEFINITIONS AND ABREVIATIONS:

A. The following definitions and abbreviations are used throughout the specifications and drawings when referring to instrumentation and control equipment, functions, and service. Definitions and abbreviations are not listed for those used in common industry practice except where to provide explicit meaning. Refer to ISA, IEEE, and other industry standard references for those not listed herein.

CSI .....Control System Integrator
ICS .....Instrumentation and Control System
OIT .....Operator Interface Terminal
HMI .....Human-Machine Interface
OWS .....Operator WorkStation
PID .....Proportional-Integral-Derivative Control
SCADA .....Supervisory Control and Data Acquisition
SSP .....SCADA System Programmer
TVSS .....Transient Voltage Surge Suppression
RTU .....Remote Telemetry Unit
PLC .....Programmable Logic Controller

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. All materials, equipment and devices shall, as a minimum, meet the requirements of UL, where UL Standards are established for those items, and the requirements of NFPA-70. All items shall have the U.L. seal where possible and all control panels shall

be U.L. labeled. All items shall be new unless specified or indicated otherwise.

B. Properly store, adequately protect and carefully handle equipment and materials to prevent damage before and during installation. Handle, store and protect equipment and materials in accordance with the manufacturer's recommendations. Replace all damaged or defective items.

C. All equipment shall be the latest and proven design. Specifications and drawings call attention to certain features, but do not purport to cover all details entering into design of the instrumentation system. The completed system shall be compatible with functions required and the equipment furnished by the Contractor.

D. All electrical components of the system shall operate on 120 volt, single phase, 60 Hz power source, except as otherwise noted in the Specifications. Drawings and Specifications indicate the energy sources that will be provided. Any other devices necessary to obtain proper operation of the instrumentation and control system from these energy sources shall be furnished with the system.

E. All necessary fuses or switches required by the instrumentation manufacturer for his equipment shall be provided with the equipment. All instruments requiring internal power supply shall have internal on-off switches.

F. The mechanical, process and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The CSI shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the ICS. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

G. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines and electrical equipment.

H. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 °C; relative humidity forty to eighty percent (40% - 80%) without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

I. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 °C with relative humidity between forty and ninety-five percent (40% – 95%).

J. Field equipment, including instrumentation and panels, may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 °C and relative humidity from ten to one hundred percent (10% - 100%). All supports, brackets and interconnecting hardware shall be aluminum, 316 stainless steel, or as shown on the installation detail drawings.

2.02 TOOLS, SUPPLIES, AND SPARE PARTS:

A. Provide special tools, other than those normally found in an electronic technician's toolbox, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance (i.e. connector pin insertion and removal tools, wire crimping tool, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.).

B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Section.

C. The CSI shall provide supplies as needed or as required by the Owner during the specified warranty period. All fuses consumed during installation, testing, startup, the system availability demonstration, and the warranty period shall be replaced by the Contractor.

D. Provide spare parts for items of ICS equipment as recommended by the manufacturer and in accordance with the Contract Documents.

E. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.

F. Refer to individual product specifications for additional requirements specific to those devices.

2.03 SIGNAL TRANSMISSION:

A. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the ICS equipment.

B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor and the CSI.

C. The CSI shall provide 24 VDC power supplies for signals and instruments where applicable and as required inside control panels, etc. Where two-wire instruments transmit directly to the instrumentation and control system, the CSI shall provide power supplies at the PLC-equipped control panels for those instruments. Where four-wire instruments with on-board loop power supplies transmit directly to the instrumentation and control system, the CSI shall provide necessary signal isolators or shall otherwise isolate the input from the ICS loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator or single loop controller with integral loop power supply is included in the loop.

D. Analog signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 mA and shall operate at 24 VDC. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels and appurtenances.

E. Non-standard analog transmission systems such as pulse duration, pulse rate and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with non-standard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 mA signal prior to transmission to other devices.

F. All discrete inputs to equipment and PLC's, from field devices, starters, panels, etc., shall be dry contacts in the field device or equipment, powered from the PLCs, unless specified otherwise. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.

G. All discrete outputs from local control panels and Instrumentation and Control System PLCs to field devices, starters, panels, etc., shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC / 120 VAC sourced from PLCs cabinet power system, as required to interface with field equipment. Outputs to solenoid valves, horns, and strobe lights shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

H. Discrete signals between starters, panels, etc. where 120 VAC is utilized shall be clearly identified in the starter, panel, etc. as being powered from a different power supply, than other starter/panel components. Where applicable, warning signs shall be affixed inside the starter, panel, etc., stating that the panel is energized from multiple sources. Output contacts in the starter, panel, etc. which are powered from other locations shall be provided with

special tags and/or color coding. Disconnecting terminal strips shall be provided for such contacts. The above requirements shall apply to all starters and panels, regardless of supplier.

2.04 NAMEPLATES:

A. All items of equipment listed in the instrument schedule, control panels and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.

B. Control panel nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

C. Field mounted nameplates shall be engraved 316 stainless steel with 22 gauge minimum thickness.

D. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

PART 3 EXECUTION

3.01 INSTALLATION:

A. The CSI shall provide the Contractor a periodic written report detailing progress of startup. This report shall include specific tabulations of devices on which startup has been completed.

B. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the

best arrangement for the work as a whole, and shall supervise the installation of ICS equipment.

C. Instrumentation and Control System equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control work, and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

D. The CSI shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the CSI shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The CSI shall also investigate, and make any field modifications to, the allocated space for each cabinet, enclosure and panel, to assure proper space and access (front, rear, side).

E. Two (2) complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or startup. All markings shall be verified and initialed by the Engineer or his designated representative. Following completion of installation and the operational readiness test, one (1) set of the marked up drawings shall be provided to the Engineer, the other retained by the CSI for incorporation of the mark-ups into final as-built documentation.

F. All work shall be in strict accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the CSI shall bear full responsibility for such violations and assume all costs arising there from.

G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

H. The Contractor shall take steps to keep electrical and control enclosures clean and free of contaminants throughout installation. Cleaning after installation only is not acceptable. Under no circumstances are electrical and control enclosures to be cleaned using compressed air to blow out dust, causing contaminants to be forced into sensitive electronics.

I. Provisions shall be made to completely capture filings (metal, etc.) when drilling into enclosures, to prevent contamination of electrical equipment.

J. Upon completion of the instrumentation and control work, the Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials and remove all surplus materials, rubbish and debris that has accumulated during the construction work. The entire area shall be left neat, clean and acceptable to the Owner.

3.02 WIRING AND GROUNDING:

A. The following wiring practice guidelines shall be used in order to minimize ground loops, to minimize electromagnetic interference/radio frequency interference (EMI/RFI) to this equipment, and to provide maximum practical immunity from damage resulting from lightning-induced transients.

B. Common wires or conductors shall not be utilized (either within panels or external to panels or for grounding of field devices) for signal shield or signal grounding, and for safety grounds.

C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch are preferred, and a maximum exposed length of two inches may be permitted where necessary. No splicing of signal wires is permitted.

D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all signal wiring shall be No. 16 AWG stranded tinned two-conductor twisted pair, with one hundred percent (100%) coverage aluminized Mylar or aluminized polyester shield and tinned copper drain wire.

E. Signal wiring within outdoor or indoor field device enclosures shall conform to the same requirements as panel wiring.

F. The shield on each process instrumentation cable shall be continuous from source to destination, and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. The signal cable for no signal shall share a common cable shield grounding wire with the signal cable shield for any other signal, and shall not share a common grounding wire with any other circuit. The length of no signal cable shield grounding wire shall not exceed two (2) inches, with less than one (1) inch maximum length preferred.

G. All outdoor instruments and all outdoor enclosures shall be grounded using the practice defined in Section 800.40 of the National Electric Code.

3.03 TESTING, GENERAL REQUIREMENTS:

A. The CSI shall test all equipment hardware and software at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the CSI shall be tested at the factory as a single fully integrated system.

B. As a minimum, testing shall include the following:

1. Operational Readiness Testing (ORT).
2. System Acceptance Testing (SAT).

C. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

D. All tests shall be conducted in accordance with prior Engineer approved procedures, forms and checklists. Each specific test to be performed shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion.

E. Copies of these sign off test procedures, forms and checklists will constitute the required test documentation.

F. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.

G. The Contractor shall require the CSI to coordinate all of his testing with all affected Subcontractors and the Owner.

H. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved test procedures.

I. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

J. The CSI shall furnish the services of technicians, all special calibration and test equipment, and labor to perform the field tests.

3.04 OPERATIONAL READINESS TESTING (ORT):

A. The entire system shall be certified (inspected, calibrated, tested and documented) that it is ready for operation. Each specified function shall be verified on a paragraph by paragraph and loop by loop basis.

B. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or startup activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein, shall not relieve the Contractor of his responsibility for meeting all specified requirements.

C. The CSI shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor

shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

D. Each instrument shall be calibrated at zero, twenty-five, fifty, seventy-five and one hundred percent (0%, 25%, 50%, 75% and 100%) of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracies as set forth by the National Institute for Standards and Technology (NIST).

E. The CSI shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

F. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

G. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over-voltage, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

H. After completion of instrumentation installation and calibration, the CSI shall perform a loop check.

The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

I. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated and adjusted on a loop by loop and component by component basis to ensure that it is in conformance with related submittals and the Contract Documents.

1. The Loop/Component Inspections and Tests shall be implemented using Engineer approved forms and check lists.

2. The Contractor shall require the CSI to maintain the Loop Status Reports and Components Calibration sheets at the job-site and make them available to the Engineer/Owner at any time.

3. These inspections and tests do not require witnessing. However, the Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.

3.05 SYSTEM ACCEPTANCE TEST (SAT):

A. Successful completion of the operational readiness test, as determined by the Engineer, shall be the basis for starting the witnessed system acceptance test. The Engineer shall approve the ORT test results and the Engineer and Owner shall be given two (2) weeks notice prior to the start of the System Acceptance Test.

B. The system acceptance test shall repeat loop and functional testing done during the operational readiness test in order to demonstrate to the Owner and Engineer that the system has been started up, is operating, and is in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph by paragraph and loop by loop basis.

C. The following documentation shall be made available to the Engineer during the test:

1. All Contract Drawings and Specifications, addenda, and change orders.
2. Master copy of the test procedure.
3. One (1) copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.

D. Any malfunction during the tests shall be analyzed and corrections made by the CSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

E. After all functions have been tested and all corrections made, the system shall operate continuously for fifteen (15) days without failure before this test will be considered successful.

F. The total availability of the system shall be greater than ninety-nine and one-half percent (99.5%) during this test period. Availability shall be defined as "Avail. = (Total Time-Down Time,) / Total Time x 100%". Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.

3.06 TRAINING:

A. The CSI shall provide project specific classroom training at the Owner’s site or designated location. Training shall be provided for the operation and maintenance of all equipment provided, as well as site specific installation configuration training for the system as a whole.

B. Each student shall be provided with training materials. All training materials shall be provided in hardcopy as well as on a training CD, with all materials in Microsoft Office or Adobe PDF file format. When a large volume of training materials is to be provided (i.e. software documentation, etc.), only electronic copies need to be provided per Engineer’s approval. When providing training materials as electronic copies only, the CSI must ensure that the training attendees will be able to use computers during the training to access

information, whether provided by the Owner or not. All training CD's shall be updated with final configurations and resubmitted for approval. Final CD media shall be archival quality.

C. Scheduling for the training sessions shall be specified by, and at the convenience of, the Owner. The CSI shall coordinate the scheduling, and shall provide written notice of available training dates, with a minimum of two (2) weeks prior notice. Candidates for training will be selected by the Owner.

D. Operator training shall be provided to familiarize operators with the system as a whole and to instruct on the function and operation of each component of the system. Training shall consist of the day-to-day operation of the system and all other operator site specific functions for this project. Instruction shall include a site walkdown of installed equipment. Two (2) courses lasting a minimum of two (2) days, with six (6) hours of instruction per day, shall be provided by the CSI.

E. Maintenance training shall be provided to maintenance personnel so that each component may be maintained without the assistance of outside organizations. The training shall be extensive so that after training, personnel shall be able to identify component malfunctions and repair components to the board replacement level. One (1) course lasting a minimum of three (3) days with six (6) hours of instruction per day shall be provided by the CSI.

F. Under the scope of this project, the CSI will not be responsible for providing PLC and HMI control programming and logic. Specific training should therefore include, but not be limited to the following: system architecture and interconnection; wiring; fiber optic systems, including maintenance and repair; field panels and equipment; radio systems; and field instrumentation and PLC hardware, including maintenance and troubleshooting.

G. Refer to related specification sections for additional training requirements.

3.8 WARRANTY:

A. During this warranty period, the CSI shall provide, at no additional cost to the Owner, the services of a trained, competent, field service engineer who shall arrive on site within thirty-six (36) hours of notification by the Owner or Engineer, to repair and/or replace any faulty device or equipment supplied by the system supplier as part of this Instrumentation and Control System.

B. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed, and list materials used. A copy of all service reports shall be delivered to the Owner on or before the next business day.

C. The CSI shall be capable of providing, after the warranty period for this system expires, a renewable service contract as specified in Section 01740 – Warranties and Bonds, whereby a trained, competent field service engineer shall arrive on site within thirty-six (36) hours of notification by the Owner. Information relative to charges for such service and availability of service shall be submitted to the Owner and the Engineer.

D. Components shall be furnished to the manufacturer's standard for service intended, unless otherwise indicated in the Specifications or on the Contract Drawings.

END OF SECTION

SECTION 13310

INSTRUMENTATION AND CONTROLS, FIELD EQUIPMENT

PART 1 - GENERAL

1.01 THE REQUIREMENT:

A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Instrumentation and Control System (ICS) as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

B. The Control System Integrator (CSI) shall provide full onsite supervision of all equipment provided under this section, where installation is provided by others.

C. Field equipment (i.e. primary elements, measuring devices, transmitters, field controllers, chart recorders, indicators, and other instrumentation and accessories) shall be provided with all components necessary for a fully functional device whether specifically mentioned in these specifications or not. This shall include, as applicable or recommended by the manufacturer: sample conditioning, sensors, sensor holder and mounting brackets, transmitter, all required cables, calibration equipment, chemicals, reagents and spare parts.

D. Specialty cables between sensors/probes and their electronics/transmitters shall be furnished with each instrument. Special cables include any type of cable not specified in Division 16 – Electrical.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements, and the sections referenced therein shall be applied.

1.03 SUBMITTALS:

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements. In addition, the following specific submittals items shall be provided:

1. An ISA specification sheet for each instrument furnished and/or calibrated shall be submitted with the field equipment submittals. The ISA data sheet shall be in accordance with ISA Standards ISA S20 "Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves" and ISA TR20.00.01 "Specification Forms for Process Measurement and Control Instruments".

2. The CSI and the field equipment manufacturer shall review the proposed installation and configuration of all field equipment, prior to submittal for approval, and shall identify any condition which shall require corrective measures. The following as a minimum shall be reviewed for the installation configuration of each instrument:

   a. Listed features
   b. Material of construction
   c. Consideration of process fluid
   d. Environmental conditions
   e. Installation location
   f. Process connections
   g. Ability to perform maintenance

3. Submit in writing in the field equipment submittal, that each piece of equipment is suitable for the proposed installation. Any proposed deviations shall be reviewed by the Engineer prior to execution.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. Unless otherwise specified, instruments shall be provided with enclosures to suit the specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls, equipment racks, or pipe stanchions. Where the field equipment's integral enclosure for a specified instrument is not available with the specified environmental rating, the field equipment shall be provided in a control enclosure as specified in Specification Section 13320 - Instrumentation and Controls, Control Enclosures.

B. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted or shown on the Contract Drawings, installed adjacent or near to the sensor, in a readily accessible location. Special cables that are required for interconnection

between sensors or probes and transmitters shall be furnished with the instrumentation devices by the associated equipment manufacturer. Special cables shall be of the required length for the equipment locations and conduit routing paths shown on the Contract Drawings. No splicing of cables will be accepted.

C. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Ambient conditions shall be -15 to 50° C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid and corrosive service conditions.

D. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 120 VAC, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

E. All analog transmitter and controller outputs shall be isolated, 4-20 mA into a load of 0-750 ohms minimum, unless specifically noted otherwise.

F. Process taps for primary sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and taps for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

G. All instrumentation exposed to sunlight shall be provided with sunshields constructed from 316 stainless steel or epoxy coated aluminum. Sunshields shall be designed to withstand regional wind and ice loads. Sunshield design shall be submitted for approval.

H. All outdoor external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation, and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to the temperature of the lines.

2.02 TOOLS, SUPPLIES AND SPARE PARTS:

A. Tools, supplies and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements, and as specified for each equipment item. In addition, the following items shall be provided:

1. One (1) remote handheld configuration device for communication with all "smart" equipment furnished under this Contract shall be provided. The device shall be capable of performing configuration, test, and format functions from anywhere on the 4-20 mA signal loop for a particular transmitter or by direct connection. For HART communications, the configuration device shall be Rosemount 475 or approved equal. Provide at least one (1) spare fuse for the device.

2. All instruments shall be supplied with one (1) year's worth of supplies, including chemicals and reagents, for the calibration, operation and maintenance of the device.

2.03 ACCESSORIES:

A. Instrument tubing shall be 1/4 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37° stainless steel flared fittings, or Swagelock or Parker-CPI flareless fittings.

B. Diaphragm seals shall be provided to systems as shown on the Contract Drawings, as specified herein and/or for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. Diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi, and elastomers for operating pressures below 15 psi. Diaphragm material shall be non-reactive with the process fluid. Refer to the Instrument Schedules for specific materials requirements. Seal shall have fill connection, 1/4-inch NPT valve flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements, and shall be provided with 316 stainless steel factory filled capillaries. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

C. Isolating ring seals shall be provided for sensing elements measuring pressure in solids bearing fluids.

D. For heavy solids/slurry applications, wherever the associated pressure instrument is used for control purposes, or where shown on the Contract Drawings, the sensor body shall be full line size wafer design, with 316 stainless steel housing and assembly flanges, and Buna N flexible cylinder lining for in-line mounting.

The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Isolating ring seals shall be RED Valve Series 40, Ronningen-Petter Iso-Ring, Moyno RKL Series W, or equal.

E. For all other solids bearing fluids, pressure shall be sensed via a 1/2" diameter spool-type isolating ring seal, mounted on a 1/2" pipe nipple at 90 degrees from the process piping. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally. Isolating ring seals for normal solids service shall be Red Valve Series 42, Ronningen-Petter Iso-Spool, or equal.

F. Isolation valves shall be 1/2-inch diameter ball valves with 316 stainless steel body, 316 stainless steel ball.

2.04 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS):

A. TVSS shall be supplied for all field equipment power, signal, and communications wires that have any portion extending outside of a building. Refer to Specification Section 13320 - Instrumentation and Controls, Control Enclosures for requirements.

2.05 PRESSURE GAUGES:

A. General: Unless otherwise noted or specified, pressure and vacuum gauges shall conform to the following:

B. Mounting Type: Gauges shall be of the stem-mounting type unless noted otherwise.

C. Construction: Gauges shall be of the bourdon tube or bellows type with 270 degrees clockwise pointer travel. Dials shall be white face with black numerals. Dial size shall be 4-1/2 inches. Connections for all gauges shall be male 1/2 NPT with square wrench flats. Wetted parts shall be corrosion-resistant to the process fluid shown and unless otherwise specified shall be the manufacturer's best quality standard. The case shall be filled with glycerin and shall be black phenolic. Accuracy shall be ±0.5 percent of span.

D. Chemical Seal: Where specified or shown in the drawings, the gauge, with optional locking device, shall be furnished with a diaphragm seal. The diaphragm seal shall have a 316 stainless steel (minimum) top and bottom housing and a 316 stainless steel diaphragm welded to the top housing. When the process fluid or pressure is not compatible with 316

stainless steel, the manufacturer shall provide a diaphragm seal compatible with the process fluid. The process connection shall be a 3/4-inch threaded connection with a flushing connection. The fill fluid shall be glycerin. A locking device shall be included from the factory on all fluid-filled instruments to prevent inadvertent loosening or removal from the seal.

E. Where no seal is specified the gauge will be supplied with a pressure limiting snubber to protect against surges and pulsations.

F. Manufacturers: The gauges shall be as manufactured by Ashcroft, McDaniels, U.S. Gauge or equal. The diaphragm seals shall be field serviceable for oil filling and as manufactured by Ashcroft, Mansfield and Green, FIT, Ametek or equal.

2.06 GAGE PRESSURE TRANSMITTERS

A. Gauge pressure transmitters shall be of the capacitance type, with a process isolated diaphragm with silicone oil fill, microprocessor based "smart" electronics, and a field adjustable 30:1 input range.
B. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally.
C. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low copper aluminum body and 316 stainless steel process wetted parts.
D. Accuracy, including nonlinearity, hysteresis, and repeatability errors shall be plus or minus 0.10 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits.
E. Output shall be linear isolated 4-20mA 24 VDC. Power supply shall be 24 VDC, two wire design.
F. Each transmitter shall be furnished with a 4 digit LCD indicator capable of displaying engineering units and/or milliamps, and mounting hardware as required.
G. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be 40 to 85 °C at zero to one hundred percent (0-100%) relative humidity.
H. Each transmitter shall have a stainless steel tag with calibration data, attached to body.
I. The capacitance pressure sensor shall be mechanically, electrically and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing.
J. Factory set correction coefficients shall be stored in the sensor's non volatile memory for correction and linearization of the sensor output in the electronics section.

K. The electronics section shall correct the digital signal from the sensor, and convert it into a 4-20 mA analog signal for transmission to receiving devices.

L. The electronics section shall contain configuration parameters and diagnostic data in non volatile EEPROM memory, and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds.

M. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service. Refer to the Contract Drawings for installations and applications.

2.07 LEVEL SWITCHES (SUSPENDED FLOAT):

A. Level Switches (Suspended Float): Float switches shall be of the non-mercury displacement type, encapsulated in polyurethane or vinyl floats.

B. The units shall be waterproof, shockproof, explosion-proof and equipped with sufficient submersible cable to extend to the control panel or junction box without splicing. Any required weights shall be provided.

C. Switches shall be suspended in the wetwell on a suitable rack or rail of stainless steel construction.

D. Suspended type float switches shall be Anchor Scientific model GSI40N0 or approved equal.

2.08 LEVEL/FLOW TRANSMITTER, ULTRASONIC TYPE:

A. Ultrasonic transmitters shall be provided for measurement of tank and wetwell levels or for flow measurement based on level over a weir or flume. Equipment shall be provided with features and accessories as described herein, suitable for the application.

B. Ultrasonic level/flow transmitters shall meet the following specifications as a minimum:

1. NEMA 4X enclosure
2. 120VAC, 60Hz input power
3. Process display with keypad for menu driven configuration
4. One (1) 4-20 mA output
5. One (1) alarm relay output
6. Non-volatile memory
7. Accuracy: 0.25 %

C. The CSI shall provide all mounting hardware and coordinate the details of the installation so that the instruments are installed in keeping with the best standard and recommended practices of the manufacturer

and conforming to the requirements set forth by the Engineer.

D. Level/flow transmitters shall be fully programmable and configurable using a keypad. The final 'As-Built' documentation shall be provided with a tabulation of the Programming Parameters used in each level/flow transmitter so that the initial calibration can be reproduced if a spare transmitter is installed.

E. Level/flow transmitters shall be provided with optional integral analog signal isolators, as part of the transmitter assembly. All conduit connections shall be sealed to prevent damage or corrosion due to vapors or wetness.

F. Ultrasonic Level/Flow Transmitters shall be Milltronics Hydroranger 200 with Echomax XPS-15 sensors. Refer to the Instrumentation Schedule Attachment for flange mounting requirements. Transmitters shall be installed using the appropriate transducer, suitable for the range of the installation. The cable provided with the transducer shall be ordered with sufficient length to provide installation without splicing the cable at any point.

G. The CSI shall provide mounting hardware components and appropriate mounting assistance to install and secure the transducers in a manner in keeping with the recommendations of the manufacturer of the equipment and in keeping with the general details provided in the drawings. All hardware shall be fabricated from corrosion resistant materials and shall utilize stainless steel hardware. The mounting system shall be secure and permanent and shall allow easy access to the sensor for servicing. All cables shall be installed in suitable rigid conduit with only short lengths of flexible conduit allowed to complete the installation.

H. In cases where the transducer is used to monitor a covered wetwell, the transducer shall be installed using a hinged protective enclosure. The enclosure shall be a special corrosion resistant instrument enclosure made of polyurethane, and stainless steel hardware. Enclosures shall be model C-6, as provided by O'Brien Corp, St. Louis, Missouri. The case shall be secured to the slab using heavy anchors over an appropriately sized hole cored through the slab. The enclosure shall also have a hole in the bottom to match the hole in the slab so that the transducer can be easily installed from above. The transducer shall be installed on a heavy aluminum plate which would lie in the bottom of the enclosure and allow the transducer to extend into the cored hole.

I. In cases where the transducer is used to monitor a water storage tank or other type of location, the CSI

shall provide a mounting design and mounting hardware to provide an installation which is appropriate for the operation of the device and easily maintained. For storage tanks, the transducer shall be mounted above the tank or a suitable bracket extending out far enough from the tank sides to receive a strong signal over the entire level range without reflections off the tank sides. The transmitter shall be mounted outside of the wall at a convenient ground-level working height.

J. In cases where the transducer is used on a chemical storage tank, the CSI shall provide a flange mounted arrangement to match the connection point on the storage tank. Flange sizes and type will be coordinated with that equipment supplier.

K. In cases where the transducer is used in a highly turbulent area, the sensor shall be flange mounted to a stilling well to minimize incorrect responses to wave action in the liquid. The stilling well shall be a six (6) inch PVC pipe which shall extend the entire depth of the measured range and to below the normal low liquid level. The stilling well shall have holes drilled periodically along the length sufficient to allow adequate response to changes in liquid level. The stilling well shall be supported in a manner which produces a rigid installation minimizing the movement due to the turbulent liquid.

L. Spare parts: Provide one (1) spare Ultrasonic Level/Flow Transmitter and one (1) spare transducer of each type used (supplied with the longest cable utilized in the project).

2.08 ULTRASONIC FLOWMETERS (TRANSIT TIME):

A. Ultrasonic Flowmeters shall consist of a dual strap-on flowmeter sensor assembly with remote signal converter/transmitter that is capable of converting and transmitting the signal from the sensors.

B. The transmitter shall utilize the characterized principles of acoustical wave travel in a water pipeline with measurements being the difference in time for signals transmitted both upstream and downstream into the flow.

C. The flowmeter accuracy shall be ≤±0.5% of reading from 2-100% meter capacity. Flow range sensitivity shall be up to 0.01 feet/sec.

D. The flow system shall include but not be limited to the following:

1. Submersible, non-intrusive encapsulated clamp-on dual-sensors with manufacturer supplied sensor

cable of sufficient length as to not require splicing.

2. SST clamps and mounting hardware
3. The cables for interconnecting the flow tube to the transmitter shall be furnished by the manufacturer and of sufficient length as to not require splicing.
4. NEMA 4X / IP65 transmitter enclosure
5. 120VAC, 60Hz input power
6. Backlit 2-line, 40 character alphanumeric process LCD display with tactile keypad for menu driven configuration
7. One (1) 4-20 mA output
8. Up to four (4) alarm relay outputs
9. Provide with configuration and operational tuning software

E. Ultrasonic Transit Time Flowmeters shall be Thermo Scientific DCT 6088.

2.09 SUNSHIELDS:

A. All outdoor mounted transmitters shall be provided with a 316 stainless steel sunshield. Sunshields are to be sized so that the sunshield will extend a minimum of three (3) inches beyond the transmitter enclosure on all sides.

B. The sunshield shall be sized to include protection for the transmitter and the surge arresting device.

C. All sunshield and instrument mounting hardware shall be 316 stainless steel.

PART 3 - EXECUTION

3.01 REQUIREMENTS:

A. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.

END OF SECTION

Southwest Water Reclamation Facility
Manatee County, Florida

Instrumentation Schedule

TAG	DESCRIPTION	SERVICE	RANGE
FE/FIT-314	Transit Time Ultrasonic Flow Transmitter	Pond Storage Return to Filter Flow	0-TBD GPM
FE/FIT-501	Transit Time Ultrasonic Flow Transmitter	Effluent Discharge Flow	0-TBD GPM
LE/LIT-301	Ultrasonic Level Transmitter (6-inch Flange)	North Reclaimed Pond P.S. Wetwell Level	0-TBD Feet
LSHH-240	Non-Mercury Float Level Switch	Waste Backwash Pump Station High Alarm Level	
LSMH-240	Non-Mercury Float Level Switch	Waste Backwash Pump Station Lag 1 Start Level	
LSML-240	Non-Mercury Float Level Switch	Waste Backwash Pump Station Lead Start Level	
LSL-240	Non-Mercury Float Level Switch	Waste Backwash Pump Station Low Cutoff Level	
LSLL-240	Non-Mercury Float Level Switch	Waste Backwash Pump Station High Alarm Level	
LSH-300	Non-Mercury Float Level Switch	North Reclaimed Pond P.S. Wetwell High Alarm Level	
LSL-300	Non-Mercury Float Level Switch	North Reclaimed Pond P.S. Wetwell Low Alarm Level	
PE/PI-241	Pressure Gauge with Diaphragm Seal	Waste Backwash Pump No. 1 Discharge Pressure	0-100 PSI
PE/PI-242	Pressure Gauge with Diaphragm Seal	Waste Backwash Pump No. 2 Discharge Pressure	0-100 PSI
PE/PI-311	Pressure Gauge with Diaphragm Seal	North Reclaimed Pump No. 1 Discharge Pressure	0-100 PSI
PE/PI-312	Pressure Gauge with Diaphragm Seal	North Reclaimed Pump No. 2 Discharge Pressure	0-100 PSI
PE/PI-313	Pressure Gauge with Diaphragm Seal	North Reclaimed Pump No. 3 Discharge Pressure	0-100 PSI
AE/AI-610	Chlorine Residual Analyzer	Effluent Chlorine Residual	0-5 PPM

SECTION 13320

INSTRUMENTATION AND CONTROLS, CONTROL ENCLOSURES

PART 1 GENERAL

1.01 THE REQUIREMENT:

A. The Contractor shall furnish, test, install and place in satisfactory operation all control enclosures (i.e. field panels, control panels, cabinets, consoles, boxes, etc.) required to provide a complete and operable Instrumentation and Control System (ICS) as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

B. The Contractor shall also be responsible to provide modifications to existing control panels as described herein or as indicated in the PLC Input/Output Schedule Attachment. Modifications to existing control panels shall also conform to the requirements of these specifications.

C. All components and all necessary accessories (e.g. mounting hardware, conditioning equipment, TVSS, fuses, circuit breakers, terminals, ground bars, relays, contactors, starters, indicators, control operators, power supplies, signal conditioning, connectors, digital hardware, etc.) that may be required to complete the system, shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements and the sections referenced therein shall be applied.

B. Instrumentation and Controls Schedules. Refer to Instrumentation Schedule and PLC Input/Output Schedule Attachments for a listing of major equipment, enclosure construction and signal monitoring requirements.

1.03 SUBMITTALS:

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements. In addition, the following specific submittals items shall be provided:

1. Cabinet sizing in relation to heat dissipation and cooling/heating system sizing calculations shall be submitted for all cabinets containing PLCs, UPSs, VFDs, SCRs and, at the request of the Engineer, for all cabinets containing sensitive electronic equipment or chemicals.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS:

A. Either manufacturer-standard or custom enclosures may be furnished, subject to the requirements of the Contract Documents and favorable review by the Engineer.

B. All enclosures shall fit within the allocated space as shown on the Drawings. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

C. A minimum estimated size is shown on the Drawings. The Contractor shall furnish enclosures of the size and quantity required to house the manufacturers' equipment supplied and all other electrical components installed in the enclosure. In addition, provide useful space and power supply capacity as spare for future expandability to a minimum of one (1) item per item type installed or twenty percent (20%) of quantity of each type item installed, whichever yields the greater spare space.

D. Enclosures (cabinets, panels, boxes, etc.) shall be formed or welded construction, reinforced with Unistrut, Powerstrut or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the supplier's equipment. Doors shall be removable. Enclosures with any dimension thirty-six (36) inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. No screws or bolts shall protrude through from the interior enclosure.

E. All steel enclosures shall be free from dirt, grease and burrs, and shall be treated with a phosphatizing metal conditioner (phosphate conversion coating) before painting. All surfaces shall be filled, sanded, and

finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six (6) color samples provided. All stainless steel enclosures shall be polished to a No. 4 finish.

F. Enclosures shall be prefabricated cabinets and panels by Hoffman, Rittal or Vynckier. The Contractor may optionally provide enclosures custom fabricated by a reputable panel fabrication shop acceptable to the Engineer.

G. Each panel shall incorporate a removable back panel on which control components shall be mounted. Back panels shall be secured to the enclosures with collar studs. All components shall be of the highest industrial quality and securely mounted to the removable back panels with screw and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

H. All enclosures with any dimension twenty-four (24) inches or larger shall be provided with drawing pockets for as-built panel drawings. One (1) laminated copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

I. All metallic enclosures with door mounted equipment shall have the door grounded by means of flexible ground strap.

J. The enclosure and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Panel mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Contract Drawings.

K. Enclosures shall provide mounting for UPS, power supplies, control equipment, input / output subsystems, panel mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. Louvered openings fitted with dust filters near the bottom and top of the cabinet shall be provided for NEMA 12 enclosures. If required, cabinets shall be provided with filtered fans, heat exchangers or air conditioners. Only closed loop cooling systems shall be provided for NEMA 4X cabinets. Cooling systems

shall be by the cabinet fabricator, McLean Midwest, Noren Products, or approved equal.

L. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker. Circuit breakers shall be provided for the following internal branch circuits distributed within the panel:

1. Receptacles and power strips
2. Lighting
3. UPS
4. HVAC equipment

M. Enclosures shall be provided with 120 volt duplex receptacles for service equipment and fluorescent service lights. Loads not requiring transient voltage surge suppression (i.e. receptacles, lighting, HVAC, branch circuits to remote equipment, etc.) shall be connected ahead of the enclosure TVSS device.

N. Locate equipment, devices, hardware, power supplies, instrumentation and controls, electrical equipment and wiring to be installed inside the enclosures and/or as facial features on the enclosures, so that connections can be easily made and so that there is ample room for servicing each item. Every component in and on the enclosures shall be able to be removed individually without affecting the other components and without the need to move other components. Support and restrain all internally, as well as panel mounted components to prevent any movement.

O. All cabinets and/or enclosures shall be NEMA rated for the environment in which it is to be installed and as noted in the Drawings.

P. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

Q. Control panels shall be built in accordance with UL508A Industrial Control Panels and NEC Article 409 Industrial Control Panels. Control panels for areas classified as Hazardous shall be built in accordance with UL698 Industrial Control Equipment for Use in Hazardous Locations. Control panels shall be UL508A and/or UL698 labeled and marked as defined in NEC 409.110 with the following:

1. Manufacturer’s name and contact information (i.e. address, phone, website, email, etc.).
2. Supply voltage, phase, frequency and full-load current.
3. Short-circuit current rating of the industrial panel based on one of the following:
   a. Short-circuit current rating of a listed and labeled assembly
   b. Short-circuit current rating established utilizing an approved method
4. Electrical wiring diagram numbers or the index sheet to the electrical wiring diagrams.
5. The enclosure type number (i.e. NEMA 1A, 3R, 12, 4X, 7, 9, etc.)
6. If the industrial control panel is intended as service equipment, it shall be marked to identify it as being suitable for use as service equipment.

2.2 TOOLS, SUPPLIES, AND SPARE PARTS:

A. Tools, supplies, and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements and as specified for each equipment item. In addition, the following items shall be provided:

1. One (1) of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract. This does not include large LCD display electronic operator interface devices.
2. Three (3) of each type of interposing relay provided under this Contract.
3. Five (5) of each type of power TVSS device used
4. Ten (10) of each type of signal TVSS device used
5. Two (2) of each type of communication TVSS device used.
6. Three (3) pints of each type or color of touchup paint for the control enclosures provided under this Contract.

2.3 OUTDOOR ENCLOSURES:

A. All outdoor enclosures shall be rated NEMA 4X, constructed of 316 stainless steel with a white powder epoxy coating finish unless specified otherwise. Outdoor enclosures shall have a hinged and gasketed door. Door latches shall be all stainless steel, fast operating clamp assemblies (quick release), which do not require bolts or screws to secure. Gaskets shall be polyurethane.

B. Outdoor panels shall be fitted with pad-lockable latch kits.

C. Outdoor enclosures with internal digital electronics, exterior indicators or exterior indicator lights shall have external sun shields or sun shades, constructed of the same materials as the associated enclosure, unless otherwise specified.

D. Outdoor enclosures shall be designed for ambient conditions of -15 to 50°C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Outdoor enclosures shall be provided with thermostatically controlled space heaters to provide condensation protection.

2.4 INDOOR ENCLOSURES:

A. Indoor enclosures located in the same area (i.e. room, etc.) as open process tanks, open process channels, closed process piping or process equipment containing wet liquids or possible airborne powders, shall be rated NEMA 4X, constructed of 316 stainless steel, fiberglass, fiberglass reinforced polyester, or polycarbonate, unless specified otherwise. Enclosures shall have a hinged and gasketed door. Door latches shall be all stainless steel, fast operating clamp assemblies (quick release) which do not require bolts or screws to secure. Gaskets shall be polyurethane.

B. Indoor enclosures located in a dry area (i.e. electrical room, etc.) shall be NEMA 12 steel, unless specified otherwise. Enclosures shall have a hinged and gasketed door. Door latches shall be three (3) point door latches with handle for all enclosures with a dimension of twenty-four (24) inches or larger, or otherwise shall be fast operating clamp assemblies which do not require bolts or screws to secure. Gaskets shall be polyurethane.

C. Indoor enclosures in a non-air conditioned space shall be designed for ambient conditions of 0 to 40°C and twenty to ninety-five percent (20% - 95%) relative humidity, unless otherwise specified. Indoor enclosures in an air conditioned space shall be designed for

ambient conditions of 20 to 30°C and twenty to eighty-five percent (20% - 85%) relative humidity, unless otherwise specified.

2.5 PLC, RTU AND OTHER DIGITAL EQUIPMENT ENCLOSURES:

A. Enclosures shall be prefabricated cabinets and panels by Hoffman, Rittal, or Vynckier. The Contractor may optionally provide enclosures custom fabricated by a reputable panel fabrication shop acceptable to the Engineer.

B. Enclosures shall be sized to provide a minimum of fifteen percent (15%) spare sub-panel mounting space for future equipment.

C. A minimum of ten percent (10%) spare terminals for each type of wiring (power, signal, DC control, AC control, etc.) shall be mounted within each control panel.

D. Outdoor enclosures shall be provided with thermal insulation and thermostatically controlled space heaters to provide condensation protection.

E. Enclosures with any dimension greater than thirty-six (36) inches which contain a programmable logic controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door.

F. NEMA 12 enclosures shall be provided with filtered louvered openings at the top and bottom of the cabinet, if required for heat dissipation.

G. Enclosures shall be provided with copper ground bars for terminating cable shields.

H. The temperature inside each enclosure containing digital hardware (i.e. cabinet, panel or console) shall be continuously monitored, and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.

2.6 TERMINALS:

A. Wiring which enters or leaves the enclosure shall be terminated to large lug type terminal strips, designed to accommodate minimum 16 AWG wiring, and permanently numbered consistent with the component schematic. These wiring termination strips shall be located with ample room to allow field wiring to be terminated in a neat and workmanlike manner.

B. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails, securely

bolted to the cabinet sub-panel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Wieland, Square D, or equal. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

C. Fused terminal blocks or miniature thermal circuit breaker terminal blocks shall be supplied for protection and isolation of enclosed equipment, or as specified in the Contract documents. Blown fuse indicators shall be provided and/or tripped breaker status shall be clearly visible. Fused or miniature thermal circuit breaker terminal blocks shall be provided for, but not limited to each of the following:

1. Each piece of equipment provided with a power supply (integral, internal or external) with the exception of devices with internal fusing plugged into a receptacle.

2. Each PLC module requiring external power

D. Terminals shall be marked with a black waterproof, permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.7 WIRING:

A. All wiring shall be bundled and run open or enclosed in vented plastic wireway, as required. All conductors run open shall be bundled and bound with nylon cable ties, at regular intervals, with intervals not to exceed twelve (12) inches. Adequately support and restrain all wiring runs to prevent sagging or other movement. Care shall be taken to separate communication, network, electronic signal, AC discrete signal, DC discrete signal and power wiring. Wiring to equipment mounted on doors or where movement of the equipment will take place shall be installed in nylon spiral wrapping sheaths.

B. Wires shall be color coded as follows:

1. Equipment Ground - GREEN
2. 120 VAC Power Distribution - BLACK
3. 120 VAC Power Neutral - WHITE
4. 120 VAC Control (Internally Powered) - RED
5. 120 VAC Control (Externally Powered) - YELLOW

6. 24 VAC Control - ORANGE
7. DC Power (+) - RED
8. DC Power (-) - BLACK
9. DC Control - BLUE
10. Analog Signal (+) - BLACK
11. Analog Signal (-) - WHITE

C. All wiring shall comply with accepted standard instrumentation and electrical practices. Field wiring for power, control and signal wires shall comply with Division 16 of the specifications. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

D. Internal panel wiring shall be as follows:

1. AC power wiring: 14 AWG minimum, stranded copper conductors, THHN/THHW wire rated for 600 volts and 90 °C. For wiring carrying more than 15 amps, use sizes required by NEC.

2. AC control and DC power and control wiring: 16 AWG minimum, stranded copper conductors, THHN/THHW wire rated for 600 volts and 90 °C.

3. Instrument signal wiring: 18 AWG stranded conductors, tinned copper, twisted pair or triad, overall one hundred percent (100%) aluminum foil shield with 20 AWG stranded drain wire, plenum rated 300V 60°C FEP insulated wire with FEP jacket, equal to Belden 88760.

4. All stranded wire shall have a minimum of sixteen (16) strands, except for drain wires.

2.8 IDENTIFICATION:

A. Provide a laminated black nameplate with beveled edges and 1/2-inch white letters to identify each console, panel or cabinet on the front of the enclosure.

B. Provide laminated, beveled edge, plastic legend plates and nameplates, with 1/4-inch letters, for each front panel mounted device as shown on the Drawings. Legend plates and nameplates shall be the size as shown on the Drawings. Color shall be black lettering on white background except caution/warning nameplates which shall be white lettering on a red background. Attach front panel nameplates with both a permanent adhesive and stainless steel machine screws into tapped holes.

C. Tag all interior instruments and other components with engraved, laminated plastic nameplates with 1/8-inch, minimum, lettering. Legends shall be consistent with wiring and layout drawings. Nameplates shall be attached with permanent adhesive to the panel, near the device or on the device itself or as otherwise approved by the Engineer.

D. Number and label each wire in the systems. Every unique wiring node shall have its own individual unique number. Numbers shall be shown on all submitted drawings. All wires shall be labeled at each termination and junction of the wire and at 30-inch intervals along the wire. All multi-conductor cables shall be labeled at each end and at 30-inch intervals with CBL-XXX and also label each conductor at both ends. Labeling shall be self laminating white/transparent self extinguishing vinyl strips (Brady DAT 7 292 or equal) with clear heat shrink tubing over the markers. Length shall be sufficient to provide at least two and one-half (2 1/2) wraps. All labels shall be machine-printed with wire and/or cable numbers.

2.9 ACCESSORIES:

A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Allen Bradley 800H, Square D Company Type SK or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.

B. Pushbuttons and selector switches shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Pilot lights shall be of the proper control voltage, LED type (indoor) and lamp type (outdoor).

C. Control operators shall have legend plates as specified herein, indicated on the Contract Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, white field (background) with black lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.

D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Contract Drawings. Modifications to existing panels using control operators and indicators of the same type and manufacturer shall be allowed with Engineer’s approval.

E. Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be miniature type with DPDT contacts rated a minimum 10 amp @ 120 VAC, push-to-test button, and status indicator. Relay coils shall be 120/240 VAC or 24 VDC as required. Relays shall be as manufactured by Idec, Square D, Omron, Allen-Bradley or approved equal.

2.10 POWER SUPPLIES:

A. Power supplies shall be enclosed and sized per the guidelines of UL508 and UL508A. Power supplies shall be Phoenix Contact, Model Quint-PS-X, or approved equal.

B. External PLC power supplies provided for loop and/or PLC power shall be redundant and alarm to the PLC upon failure.

2.11 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS):

A. Transient voltage surge suppressors shall be provided at the following minimum locations:

1. At any connections between AC power and electrical and electronic equipment, including panels, assemblies and field mounted instruments.

2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3. At both ends of all copper-based communications cables that extend outside of a building.

4. At all specified spare analog inputs and outputs in PLCs and RTUs.

B. These protective devices shall be external to and installed in addition to any protective devices built into the equipment. Power and signal protection shall be installed either in a NEMA 4X enclosure or in the enclosure that houses the equipment to be protected.

C. All surge arrestors shall be mounted and wired per the manufacturer’s recommendations including local grounding for surge energy dissipation. For surge suppressors use No. 8 cable for ground connection or install suppressor directly on ground bus using grounding screw. Provide 1-inch wide by 1/8-inch thick copper ground bus as a minimum.

D. Panel-mounted power circuit protectors shall be provided in all enclosures powered by 120 VAC. The protector shall be a 3-stage hybrid, solid-state power line protector with noise filtering, common mode and normal mode suppression and nanosecond reaction time. The unit shall include a replaceable fuse to remove the load (protected equipment) from the line if the unit is either overloaded or the internal protection fails. TVSS devices shall be EDCO HSP-121BT-1RU or approved equal.

E. Panel-mounted signal circuit protectors shall be made for mounting on a terminal block rail. Each TVSS shall include a moveable grounding link to allow each signal cable shield to be individually grounded to the panel via the mounting rail through the TVSS for that cable without the use of any additional grounding wire or to be isolated from ground at the TVSS. Each mounting rail shall be grounded to the panel by the use of rail mounting screws at approximately one-foot intervals. Protection shall be from line to line and from each line to ground. Protection shall also be from shield to ground where the shield is not grounded at the protector. Each TVSS shall have the ability to protect against surge currents greater than 10,000 amperes. Each TVSS shall add no more than 22 ohms per signal wire to the total signal loop resistance of the analog signal loop in which it is installed. TVSSs shall not introduce error-producing ground loop currents into the instrumentation signal circuits. TVSS devices shall be EDCO DRS-036, Phoenix Contact or approved equal.

F. Signal circuit TVSS for 2-wire field instruments shall be a conduit connected/pipe nipple type and shall have characteristics equal to the panel mounted devices. Units shall be mounted to a transmitter conduit entry point where available. When not available or practical, then these devices shall be mounted in NEMA 4X enclosures located at the field devices. TVSS devices shall be EDCO SS65-036, Phoenix Contact or approved equal.

G. Signal circuit TVSS for 4-wire field instruments shall be a separate enclosure unit capable of providing protection on both the power and signal side. The unit shall contain the characteristics of the line power protector and signal circuit protectors discussed above. Units shall be enclosed in a manufacturer assembled NEMA 4X polycarbonate enclosure with a clear polycarbonate cover. TVSS devices shall be EDCO SLAC-12036, Phoenix Contact or approved equal.

H. TVSS devices antenna cable signal protection shall be an in-line panel mount type unit rated for 50 Ohms and with

dc blocking. Unit shall be rated for the appropriate frequency range and have an insertion loss of 0.1 dB. TVSS device shall be a Polyphaser IS-50 series or approved equal.

I. TVSS device specifications and ratings for signal or communications types not defined herein shall be as specified elsewhere or of a type recommended by the manufacturer of the device being protected. TVSS devices shall be Phoenix Contact, EDCO, Polyphaser or Innovative Technology.

PART 3 EXECUTION

3.01 REQUIREMENTS:

A. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.

B. Floor mounted enclosures shall be installed on 1/4-inch thick rubber type pads. These pads shall completely cover the area of the base that is against the floor.

C. Keep enclosures clean at all times. Keep enclosure doors closed except when actually working in the enclosure. Protect all equipment during installation, including hole punching for conduit connection. Remove all filings and thread cuttings from enclosures. Careful attention must be paid to provide installations which are both functional and aesthetically acceptable.

D. All conduits used in conjunction with control panels or instrumentation of any kind shall be sealed using a suitable duct-sealing compound to minimize the possible damage caused by vapors or wetness. It shall be the responsibility of the CSI to verify that this is accomplished early in the project, so that corrosion damage does not occur during the time of construction.

E. The Contractor shall provide the Engineer a periodic written report detailing construction progress. This report shall include specific tabulations of equipment on which construction/installation has been completed.

F. Equipment shall be located so that it is accessible for operation and maintenance. The CSI shall examine the Contract Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole and shall supervise the installation of all equipment.

G. All UPS units shall be mounted on raised platforms so as to not rest on the panel bottom.

3.02 WIRING AND GROUNDING:

A. The following wiring practice guidelines shall be used in order to minimize ground loops, minimize the effects of electromagnetic interference/radio frequency interference (EMI/RFI) and to provide maximum practical immunity from damage resulting from lightning-induced transients.

B. Common wires or conductors shall not be utilized (either within panels or external to panels, or for grounding of field devices) for signal shielding, signal grounding, or safety grounds.

C. Exposed wire lengths extending from within shielded signal cables shall be minimized to reduce pick-up of EMI/RFI by signal circuits. Exposed lengths of less than one inch is preferred with a maximum exposed length of two inches only permitted where necessary. No splicing of signal wires shall be permitted.

D. All signal wiring shall be shielded, both within panels and external to panels. Unless otherwise specified, all signal wiring shall be No. 16 AWG stranded tinned two-conductor twisted pair with 100 percent coverage of aluminized Mylar or aluminized polyester shield and tinned copper drain wire.

E. The shield on each process instrumentation cable shall be continuous from source to destination, and grounded at one end only. In general, grounding of signal cable shields shall be done at the control panel end. No signal cable shall share a common cable shield grounding wire with any other signal cable or other circuit. The exposed length of cable shield grounding wires shall not exceed two inches prior to termination with less than one-inch maximum length preferred.

F. All outdoor instruments and all outdoor enclosures shall be grounded using the practice defined in Section 800.40 of the National Electric Code.

END OF SECTION

SECTION 13330

INSTRUMENTATION AND CONTROLS, SCADA HARDWARE

PART 1 GENERAL

1.01 THE REQUIREMENT:

A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment required to provide a complete and operable Supervisory Control and Data Acquisition (SCADA) system, as specified herein and as shown on the Contract Drawings, even if each needed item is not specifically specified or shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. In addition to the requirements specified in this section, the requirements of specification Section 13300 - Instrumentation and Controls, General Requirements and the sections referenced therein shall be applied.

1.03 SUBMITTALS:

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples and as specified in Section 13300 - Instrumentation and Controls, General Requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. The SCADA hardware configuration as specified herein, as specified in related sections and as shown on the Contract Drawings depicts overall system configuration requirements. Unless otherwise specified, designs which vary from this concept will be rejected.

B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level.

C. PLC-to-PLC communication protocols shall be Ethernet based.

2.02 TOOLS, SUPPLIES, AND SPARE PARTS:

A. Tools, supplies and spare parts shall be provided as specified in Section 13300 - Instrumentation and Controls, General Requirements, and as specified for

each equipment item. In addition, the following items shall be provided:

1. One (1) of each type of CPU module for PLC equipment furnished under this Contract.

2. One (1) of each type of communication module for PLC equipment furnished under this Contract.

3. Two (2) of each type of input/output module for PLC equipment furnished under this Contract.

4. Two (2) of each type and size of PLC and equipment power supply furnished under this Contract.

5. One (1) data communications radio.

2.03 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS):

A. Refer to specification Section 13320 – Instrumentation and Controls, Control Enclosures for TVSS requirements.

B. Provide TVSS protection for all specified spare analog inputs and outputs.

2.04 UNINTERRUPTIBLE POWER SUPPLIES (UPS):

A. UPS units shall be provided for all new SCADA panels and computers.

B. UPS units at sites without ATS and generators shall be sized to provide a minimum of thirty (30) minutes backup time. At sites with ATS and generators, UPS units shall be sized for a minimum of fifteen (15) minutes. Each UPS shall consist of a free standing UPS module and battery modules as required to meet backup runtime requirements.

C. UPS units provided for SCADA computers shall be connected to the computer via a digital communication port to provide status and automatic shutdown of the computer.

D. UPS units provided for PLCs shall be provided with a dry contact output to alarm on UPS trouble or failure. This fail output shall be wired into the PLC I/O to represent UPS status.

E. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories plus twenty percent (20%) spare capacity. Upon loss of the AC supply, the inverter shall continue to supply normal

power to the device, drawing DC power from the batteries.

F. Each UPS shall meet the following requirements:

1. Input voltage shall be 117 VAC, single phase, 60 Hz.
2. Voltage regulation shall be plus or minus five percent (±5%) for line and load changes.
3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz (±0.5%) when on battery operation.
4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, suitable for high temperatures.
5. Sound absorbing enclosure.
6. EMI/RF noise filtering.
7. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
8. Adjustment allowed to prevent UPS from going offline when on a standby generator supplied power source.

G. UPS systems shall be APC, Powerware Ferrups, or approved equal.

2.05 PROGRAMMABLE LOGIC CONTROLLERS (PLC), GENERAL:

A. The CSI shall furnish programmable logic controllers (PLCs) as specified herein and as shown on the Drawings. PLCs shall be provided complete with rack, power supply, I/O cards, special function cards, instructions, memory, input/output capacity and appurtenances to provide all features and functions as described herein. PLC I/O cards may be supplied by third party vendors if approved by the PLC manufacturer and the Engineer. No substitutions will be permitted.

B. All components of the PLC system shall be of the same manufacturer, who shall have fully tested units similar to those being furnished, in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein, based on the program stored in memory and the status of the inputs and outputs.

C. The programmable controller shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of five to ninety-five percent (5% - 95%), non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz, or 24 VDC if provided with a battery backup system. Overcurrent and undervoltage protection shall be provided on the power supply.

D. System configuration shall be as shown on the Contract Drawings. PLC types shall be designated on the Communications System diagram and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. Memory, processor and PLC type shall be adequate for all control functions specified. Memory backup shall be provided during loss of power for the configuration, logic program and current operating parameters/addresses.

E. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm. Memory shall consist of battery-backed RAM or EEPROM, which shall retain the control program for at least one (1) year, in the event of power loss. Visual indication shall be provided if battery charge is insufficient to maintain the program in RAM memory for at least two (2) weeks.

F. The instruction set for the PLC shall include the following, as a minimum:

1. Relay type instructions
2. Counter and timer instructions
3. Comparison instructions (equal, greater than, limit tests, etc.)
4. Integer, long integer and floating point mathematical instructions
5. Advanced math and trigonometric functions
6. Matrix and array instructions
7. Logical instructions (and, not, or, etc.)
8. Bit modification, moving and shift instructions
9. Diagnostic instructions

10. Sequencer instructions
11. Program control instructions (jump, goto, subroutine, etc.)
12. PID control loops
13. Block read and write capability
14. Master and slave communications capabilities
15. Immediate I/O and communications update instructions
16. Real-time clock and date

G. In addition to a communications port for communications as shown on the Contract Documents, additional communication ports shall be provided for any other devices as required (i.e., operator interface unit, connection to a notebook computer for programming and configuration).

2.06 PLC TYPE FOR SCADA PANELS:

A. PLCs for in-plant SCADA panels as specified or shown in the Contract Documents shall meet the general requirements for PLCs and shall meet but not be limited to the following requirements:

1. 10/100 Mbps Ethernet Port
2. Minimum Rack Size: Thirteen (13) slots, not to include processor or power supply
3. I/O modules shall be of a dedicated type, i.e. AI, AO, DI, DO. No mixed I/O modules shall be acceptable.
4. Memory and I/O sized to meet functional requirements.
5. PLC manufacturer type shall be coordinated with existing facility PLCs so that the same software programming language is used for all PLCs. PLCs shall be Allen–Bradley SLC-5/05 series, 64 K memory (1747-L553).

2.07 PLC INPUTS/OUTPUTS FOR SCADA PANELS:

A. Input/output hardware within SCADA panels shall be plug-in modules in associated I/O rack assemblies. Each PLC within an enclosure shall handle the required number of process inputs and outputs, plus a minimum of ten percent (10%) pre-wired spares for each I/O type furnished, with the exception of discrete inputs, which shall have a minimum of twenty percent (20%) pre-wired spares, plus a minimum of twenty percent (20%) spare I/O

rack expansion space for the addition of future circuit cards or modules.

B. PLC input/output systems and processing modules shall be of the same model series.

C. Discrete inputs (DI) shall be 24 VDC (integral to PLC), developed from dry field contacts. Units shall be Allen Bradley Model 1746-IB16, 16-point discrete input modules.

D. Discrete outputs (DO) shall be 120 VAC / 28 VDC 5A dry contacts. Output contacts may be powered from the field equipment or powered from 24 VDC / 120 VAC sourced from PLC control panel's power system, as required to interface with field equipment. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise. Provide interposing relays as specified in Section 13320 – Instrumentation and Controls, Control Enclosures as required to meet dry contact rating. Units shall be Allen Bradley Model 1746-OW16, 16-point relay output modules.

E. Analog input (AI) circuits shall be isolated, 12-bit (minimum) resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Each input circuit shall have optical isolation to protect the equipment against high voltage transients. Units shall be Allen Bradley Model 1746-NI8, 8-channel analog input module.

F. Analog outputs (AO) shall be coordinated with the receivers but shall generally be isolated 24 VDC, 4-20 mA outputs powered from the PLC. Each output circuit shall have optical isolation to protect the equipment against high voltage transients. Units shall be Allen Bradley Model 1746-NO8I, 8-channel analog output module.

G. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms which can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. #22...#12 AWG (0.2...4 mm2) wire.

H. Output failure mode shall be selectable so that upon station or communication system failure, all outputs shall be placed in the non-conducting mode or remain as they were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

I. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one-half (1/2) of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one (1) loop or piece of equipment.

J. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements, plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm to the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein.

K. Manufactured PLC cabling systems may be used to replace individual wiring of I/O to terminal blocks. Cabling system shall consist of an I/O module connector, multiconductor cable and an interface module consisting of terminals. The terminals shall accept 22-12 AWG wire and be rated for the signals carried. If required, an interface module may consist of components (fuses, relays, surge protection, etc.) and terminals. PLC cabling systems shall be as manufactured by Allen-Bradley, Phoenix Contact, Weidmüller, or approved equal.

L. Control circuits and signals entering hazardous areas shall be provided with intrinsically safe barriers meeting the requirements of the NEC and UL698.

2.08 EXPANDED UNMANAGED ETHERNET SWITCH

A. Industrial fiber optic Ethernet switches for use within control panels for communications on the facility SCADA network.

B. The switch shall be a combination fiber optic/copper Ethernet network unit.

C. The switch shall include fourteen (14) twisted pair RJ-45 ports with 10/100 MBps autonegotiation capability.

D. The unit shall include two (2) multimode SC fiber optic ports to match existing connections.

E. Switches shall use 24 VDC power with redundant power terminals available.

F. Unit shall be: Phoenix Contact, FL SWITCH SF 14TX/2FX (28 32 59 3).

2.09 STANDARD UNMANAGED ETHERNET SWITCH

A. Industrial fiber optic Ethernet switches for use within control panels for communications on the facility SCADA network.

B. The switch shall be a combination fiber optic/copper Ethernet network unit.

C. The switch shall include six (6) twisted pair RJ-45 ports with 10/100 MBps autonegotiation capability.

D. The unit shall include two (2) multimode SC fiber optic ports to match existing connections.

E. Switches shall use 24 VDC power with redundant power terminals available.

F. Unit shall be: Phoenix Contact, FL SWITCH SF 6TX/2FX (28 32 93 3).

2.10 FIBER OPTIC MEDIA CONVERTER:

A. Industrial fiber optic media converter for converting between fiber optic and copper cable. Refer to the design drawings for specific instances of utilization.

B. The converter shall include one (1) twisted pair RJ-45 port 10/100 Mbps and one 1300 nm SC type connector to match with unmanaged Ethernet switches.

C. Unit shall be 24 VDC powered and DIN rail mounted.

D. Unit shall be: Phoenix Contact, FL MC 10/100BASE-T/FO G1300 (27 08 16 4).

2.11 FIBER OPTIC CABLE SYSTEM:

A. Fiber Optic Cables

1. Fiber optic cables shall be heavy-duty, multi-fiber breakout style cable, designed for high tensile strength and durability, and suitable for installation in aerial runs and for long pulls

through conduit. Cables shall be specially designed for outdoor environments.

2. Cables shall be suitable for installation with a rated pull strength capability in excess of 340 lbs. The CSI shall use procedures, measurements and precautions so that no more than 50% of the maximum rated pull strength capability of the cable is ever applied during any point in the installation procedure.

3. Cables shall be suitable for installation with a minimum bend radius of three (3) inches or less. The CSI shall use procedures, measurements and precautions so that the cable is never exposed to a bend radius of less than six (6) inches during any point in the installation procedure.

4. Jacketing shall be polyethylene, with high abrasion and cut-through resistance. Outer jacket shall be UV stabilized for outdoor use and overall ruggedness. Jackets shall have low friction resistance and high strength so that long pulls in conduit will not cause damage.

5. Fibers shall have a 62.5-micron core. Multimode fiber core shall utilize low loss fiber, with a typical maximum attenuation of 3.0 dB/km.

6. Each sub-channel shall be tight buffered with a 2.5 mm PVC jacket, and internal strength fibers. Subchannels shall be breakout style, for ease of handling.

7. Fibers shall be hard silica clad, with a thin hard polymer optical cladding, over a pure fused silica core. Cables shall have Kevlar ripcord and all subchannels shall be color-coded.

8. Cables shall have a minimum of six (6) fibers or additional fibers as shown in the contract drawings.

9. Fiber-optic cables shall be manufactured by Corning, Belden, 3-Com or approved equal.

B. Fiber Optic Patch Panels

1. Fiber Optic cables shall always be terminated at protected fiber optic patch panels, which shall be designed to protect the terminated cables and provide a fiber-termination terminal strip for connections to local equipment.

2. Each control panel or termination area which connects to fiber optic cables shall be provided with one or more fiber optic patch panels, with sufficient termination points for every fiber in every cable. The installer shall terminate, test and secure every fiber within every cable, even if the additional fibers are designated as “spare” or “future by others”.

3. Patch panel termination connectors shall be SC or ST-style. Connectors are to remain individually booted until used.

4. Where fibers are to be connected to local equipment, a pre-terminated fiber jumper of suitable length shall be provided to make the connection between the patch panel and the equipment.

5. Patch panels shall be Corning or approved equal.

PART 3 EXECUTION

3.01 REQUIREMENTS:

A. Fiber optic cables shall be installed in one section without splicing from one designated termination point to the next.

B. The installed cable shall be terminated on all fibers. Fibers shall be tested individually with all strands providing full light transmission. If any fiber within the cable fails the testing criteria, the entire cable shall be replaced at no additional cost to the Owner.

C. Cables shall be tested under actual loading conditions using a light source and calibrated digital power meter. The Power Budget of the fiber with connectors shall be calculated and compared to actual measurements. Any significant visual defect or power loss in excess of 2 dB shall be cause for a failed test.

D. A written report shall be prepared for each fiber test, troubleshooting or maintenance event. The report shall identify the fiber serviced or tested, define the procedure, describe the results of the testing including comparison to the calculated Power Budget and provide conclusions. The report shall be submitted to the Engineer for review.

E. In addition to the requirements specified in this section, refer to Section 13300 - Instrumentation and Controls, General Requirements.

END OF SECTION

Southwest Water Reclamation Facility
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PLC Input / Output Schedule

TAG	DESCRIPTION	TYPE	MIN	MAX	EGU	PANEL	COMMENTS
OA-210	Lake Filter No. 1 Common Alarm	DI	NORMAL	ALARM		SP-15	
OA-213	Lake Filter No. 1 Overflow	DI	NORMAL	ALARM		SP-15	
OA-214-1	Lake Filter No. 1 Drive Motor No. 1 Overload	DI	NORMAL	ALARM		SP-15	
OA-214-2	Lake Filter No. 1 Drive Motor No. 1 Fail	DI	NORMAL	FAIL		SP-15	
OL-214	Lake Filter No. 1 Drive Motor No. 1 Run Status	DI	OFF	ON		SP-15	
OA-215-1	Lake Filter No. 1 Drive Motor No. 2 Overload	DI	NORMAL	ALARM		SP-15	
OA-215-2	Lake Filter No. 1 Drive Motor No. 2 Fail	DI	NORMAL	FAIL		SP-15	
OL-215	Lake Filter No. 1 Drive Motor No. 2 Run Status	DI	OFF	ON		SP-15	
OL-216	Lake Filter No. 1 In Backwash	DI	OFF	BACKWASH		SP-15	
OA-220	Lake Filter No. 2 Common Alarm	DI	NORMAL	ALARM		SP-15	
OA-223	Lake Filter No. 2 Overflow	DI	NORMAL	ALARM		SP-15	
OA-224-1	Lake Filter No. 2 Drive Motor No. 1 Overload	DI	NORMAL	ALARM		SP-15	
OA-224-2	Lake Filter No. 2 Drive Motor No. 1 Fail	DI	NORMAL	FAIL		SP-15	
OL-224	Lake Filter No. 2 Drive Motor No. 1 Run Status	DI	OFF	ON		SP-15	
OA-225-1	Lake Filter No. 2 Drive Motor No. 2 Overload	DI	NORMAL	ALARM		SP-15	
OA-225-2	Lake Filter No. 2 Drive Motor No. 2 Fail	DI	NORMAL	FAIL		SP-15	
OL-225	Lake Filter No. 2 Drive Motor No. 2 Run Status	DI	OFF	ON		SP-15	
OL-226	Lake Filter No. 2 In Backwash	DI	OFF	BACKWASH		SP-15	
OA-230	Lake Filter No. 3 Common Alarm	DI	NORMAL	ALARM		SP-15	
OA-233	Lake Filter No. 3 Overflow	DI	NORMAL	ALARM		SP-15	
OA-234-1	Lake Filter No. 3 Drive Motor No. 1 Overload	DI	NORMAL	ALARM		SP-15	
OA-234-2	Lake Filter No. 3 Drive Motor No. 1 Fail	DI	NORMAL	FAIL		SP-15	
OL-234	Lake Filter No. 3 Drive Motor No. 1 Run Status	DI	OFF	ON		SP-15	
OA-235-1	Lake Filter No. 3 Drive Motor No. 2 Overload	DI	NORMAL	ALARM		SP-15	
OA-235-2	Lake Filter No. 3 Drive Motor No. 2 Fail	DI	NORMAL	FAIL		SP-15	
OL-235	Lake Filter No. 3 Drive Motor No. 2 Run Status	DI	OFF	ON		SP-15	
OL-236	Lake Filter No. 3 In Backwash	DI	OFF	BACKWASH		SP-15	
LAL-240	Waste Backwash Pump Station Low Level	DI	OFF	LOW		SP-15	
LAH-240	Waste Backwash Pump Station High Level	DI	OFF	HIGH		SP-15	
OL-241	Waste Backwash Pump No. 1 Run Status	DI	OFF	ON		SP-15	
OA-241	Waste Backwash Pump No. 1 Fail	DI	NORMAL	FAIL		SP-15	
OL-242	Waste Backwash Pump No. 2 Run Status	DI	OFF	ON		SP-15	
OA-242	Waste Backwash Pump No. 2 Fail	DI	NORMAL	FAIL		SP-15	
LAL-300	North Pond Wetwell Level Low Alarm	DI	OFF	LOW		SP-14	
LAH-300	North Pond Wetwell Level High Alarm	DI	OFF	HIGH		SP-14	
LI-301	North Pond Wetwell Level	AI	0	???	FEET	SP-14	
OL-311-1	North Pond Pump No. 1 In Remote	DI	LOCAL	REMOTE		SP-14	
OL-311-2	North Pond Pump No. 1 VFD In Remote	DO	LOCAL	REMOTE		SP-14	
OL-311-3	North Pond Pump No. 1 Run Status Indication	DO	OFF	ON		SP-14	
OA-311-1	North Pond Pump No. 1 Fail Indication	DO	NORMAL	FAIL		SP-14	
HS-311-1	North Pond Pump No. 1 Run Command from LCP	DI	OFF	ON		SP-14	
SI-311-1	North Pond Pump No. 1 Speed Feedback Indication	AO	0	100	%	SP-14	
SC-311-1	North Pond Pump No. 1 Speed Command from LCP	AI	0	100	%	SP-14	
OL-312-1	North Pond Pump No. 2 In Remote	DI	LOCAL	REMOTE		SP-14	
OL-312-2	North Pond Pump No. 2 VFD In Remote	DO	LOCAL	REMOTE		SP-14	
OL-312-3	North Pond Pump No. 2 Run Status Indication	DO	OFF	ON		SP-14	
OA-312-1	North Pond Pump No. 2 Fail Indication	DO	NORMAL	FAIL		SP-14	
HS-312-1	North Pond Pump No. 2 Run Command from LCP	DI	OFF	ON		SP-14	
SI-312-1	North Pond Pump No. 2 Speed Feedback Indication	AO	0	100	%	SP-14	
SC-312-1	North Pond Pump No. 2 Speed Command from LCP	AI	0	100	%	SP-14	

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OL-313-1	North Pond Pump No. 3 In Remote	DI	LOCAL	REMOTE		SP-14	
OL-313-2	North Pond Pump No. 3 VFD In Remote	DO	LOCAL	REMOTE		SP-14	
OL-313-3	North Pond Pump No. 3 Run Status Indication	DO	OFF	ON		SP-14	
OA-313-1	North Pond Pump No. 3 Fail Indication	DO	NORMAL	FAIL		SP-14	
HS-313-1	North Pond Pump No. 3 Run Command from LCP	DI	OFF	ON		SP-14	
SI-313-1	North Pond Pump No. 3 Speed Feedback Indication	AO	0	100	%	SP-14	
SC-313-1	North Pond Pump No. 3 Speed Command from LCP	AI	0	100	%	SP-14	
OL-311-1	North Pond Pump VFD No. 1 In Remote	NDI	LOCAL	REMOTE		VFD-1	
OL-311-3	North Pond Pump VFD No. 1 Run Status Indication	NDI	OFF	ON		VFD-1	
OA-311-1	North Pond Pump VFD No. 1 Fail Indication	NDI	NORMAL	FAIL		VFD-1	
HS-311-1	North Pond Pump VFD No. 1 Run Command from LCP	NDO	OFF	ON		VFD-1	
SI-311-1	North Pond Pump VFD No. 1 Speed Feedback Indication	NAI	0	100	%	VFD-1	
SC-311-1	North Pond Pump VFD No. 1 Speed Command from LCP	NAO	0	100	%	VFD-1	
OL-312-1	North Pond Pump VFD No. 2 In Remote	NDI	LOCAL	REMOTE		VFD-2	
OL-312-3	North Pond Pump VFD No. 2 Run Status Indication	NDI	OFF	ON		VFD-2	
OA-312-1	North Pond Pump VFD No. 2 Fail Indication	NDI	NORMAL	FAIL		VFD-2	
HS-312-1	North Pond Pump VFD No. 2 Run Command from LCP	NDO	OFF	ON		VFD-2	
SI-312-1	North Pond Pump VFD No. 2 Speed Feedback Indication	NAI	0	100	%	VFD-2	
SC-312-1	North Pond Pump VFD No. 2 Speed Command from LCP	NAO	0	100	%	VFD-2	
OL-313-1	North Pond Pump VFD No. 3 In Remote	NDI	LOCAL	REMOTE		VFD-3	
OL-313-3	North Pond Pump VFD No. 3 Run Status Indication	NDI	OFF	ON		VFD-3	
OA-313-1	North Pond Pump VFD No. 3 Fail Indication	NDI	NORMAL	FAIL		VFD-3	
HS-313-1	North Pond Pump VFD No. 3 Run Command from LCP	NDO	OFF	ON		VFD-3	
SI-313-1	North Pond Pump VFD No. 3 Speed Feedback Indication	NAI	0	100	%	VFD-3	
SC-313-1	North Pond Pump VFD No. 3 Speed Command from LCP	NAO	0	100	%	VFD-3	
FI-314	North Pond Pump Station Discharge Flow	AI	0	???	GPM	SP-14	
OL-314	North Pond Pump Station Discharge Valve In Remote	DI	OFF	REMOTE		SP-14	
ZIO-314	North Pond Pump Station Discharge Valve Open	DI	OFF	OPEN		SP-14	
ZIC-314	North Pond Pump Station Discharge Valve Closed	DI	OFF	CLOSED		SP-14	
ZCO-314	North Pond Pump Station Discharge Valve Call to Open	DO	OFF	OPEN		SP-14	
ZCC-314	North Pond Pump Station Discharge Valve Call to Close	DO	OFF	CLOSE		SP-14	
OL-315	North Pond Pump Station Pond Recirculaion Valve In Remote	DI	OFF	REMOTE		SP-14	
ZIO-315	North Pond Pump Station Pond Recirculaion Valve Open	DI	OFF	OPEN		SP-14	
ZIC-315	North Pond Pump Station Pond Recirculaion Valve Closed	DI	OFF	CLOSED		SP-14	
ZCO-315	North Pond Pump Station Pond Recirculaion Valve Call to Open	DO	OFF	OPEN		SP-14	
ZCC-315	North Pond Pump Station Pond Recirculaion Valve Call to Close	DO	OFF	CLOSE		SP-14	
FI-501	Effluent Pump Station Discharge Flow	AI	0	???	GPM	SP-13	
OL-502	Effluent Pump Station Reclaimed Valve In Remote	DI	OFF	REMOTE		SP-13	
ZIO-502	Effluent Pump Station Reclaimed Valve Open	DI	OFF	OPEN		SP-13	
ZIC-502	Effluent Pump Station Reclaimed Valve Closed	DI	OFF	CLOSED		SP-13	
ZCO-502	Effluent Pump Station Reclaimed Valve Call to Open	DO	OFF	OPEN		SP-13	
ZCC-502	Effluent Pump Station Reclaimed Valve Call to Close	DO	OFF	CLOSE		SP-13	
ZIC-503	Effluent Pump Station Reject Valve Closed	DI	OPEN	CLOSED		SP-13	
ZCO-503	Effluent Pump Station Reject Valve Enable	DO	DISABLE	ENABLE		SP-13	
OL-605-1	Sodium Hypochlorite Metering Pump No. 1 In Remote	DI	OFF	REMOTE		SP-9	
OL-605-1	Sodium Hypochlorite Metering Pump No. 1 Run Status	DI	OFF	ON		SP-9	
OA-605	Sodium Hypochlorite Metering Pump No. 1 Fail	DI	NORMAL	FAIL		SP-9	
HS-605	Sodium Hypochlorite Metering Pump No. 1 Run Command	DO	OFF	ON		SP-9	
SI-605	Sodium Hypochlorite Metering Pump No. 1 Speed Feedback	AI	0	100	%	SP-9	
SC-605	Sodium Hypochlorite Metering Pump No. 1 Speed Command	AO	0	100	%	SP-9	
OL-606-1	Sodium Hypochlorite Metering Pump No. 2 In Remote	DI	OFF	REMOTE		SP-9	

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OL-606-1	Sodium Hypochlorite Metering Pump No. 2 Run Status	DI	OFF	ON		SP-9	
OA-606	Sodium Hypochlorite Metering Pump No. 2 Fail	DI	NORMAL	FAIL		SP-9	
HS-606	Sodium Hypochlorite Metering Pump No. 2 Run Command	DO	OFF	ON		SP-9	
SI-606	Sodium Hypochlorite Metering Pump No. 2 Speed Feedback	AI	0	100	%	SP-9	
SC-606	Sodium Hypochlorite Metering Pump No. 2 Speed Command	AO	0	100	%	SP-9	

SECTION 15050

PIPE AND PIPE FITTINGS - GENERAL STATEMENT

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. General:

1. Furnish all labor, materials, tools, equipment, and services for all pipe and pipe fittings as indicated in accordance with provisions of Contract Documents.

2. Completely coordinate with work of all other trades.

3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation.

4. See Division 1 for General Requirements.

B. Related specification sections include but are not limited:

1. 15062 - Ductile Iron Pipe and Fittings

2. 15063 – High Density Polyethylene (HDPE) Pipe

3. 15067 – Plastic Pipe for Pressure Service

4. 15100 - Valves and Appurtenances

1.02 SUBMITTALS

A. All submittals shall be in accordance with Specification 01340 – Shop Drawings, Project Data and Samples.

B. Verify on shop drawings, dimensions, schedule of pipe, linings, coatings, fittings, hangers, supports, and miscellaneous appurtenances. When special fittings are necessary, verify locations of items and include complete details.

C. Yard piping drawings. Submit scaled drawings showing locations and dimensions to and from fittings, valves, structures, gates, and related appurtenances. Provide scaled drawings to a minimum scale of 1/8-inch equals 1-foot. Provide details to minimum scale of 1/8-inch equals 1-foot. Information shall include but not necessarily be limited to:

1. Dimensions of piping lengths

2. Invert or centerline elevations of piping crossings

3. Acknowledgment of bury depth requirements

4. Details of fittings, tapping locations, thrust blocks, restrained joint segments, harnessed joint segments, hydrants, and related appurtenances.

5. Line slopes and vents

PART 2 PRODUCTS

2.01 GENERAL PIPING SYSTEMS

A. Unless otherwise shown on drawings or drawing schedule, piping system materials, fittings, and appurtenances are subject to requirements of specific technical specifications and shall be as follows:

Service Category	Pipe Size Range in Inches	Above Ground or Below Ground	Piping System
BWW – Waste Backwash RCWR – Reclaimed Water Return RECIRC – Reclaimed Water Recirculation REJ – Reject Of-Overflow RCW – Reclaimed Water	4 to 42	Above Ground	AWWA C115 and C151, Class 53 ductile iron, cement-lined, flanged, AWWA C110 and C111 flanged ductile iron fittings, cement-lined or fusion bonded epoxy lining

RCW - Reclaimed Water OF - Overflow (Disk Filters) REJ - Reject	30 to 36	Below Ground	AWWA C150 and C151 ductile iron pipe, 150 psi pressure class, push-on joints, cement-lined, coal tar epoxy coating AWWA C110 ductile iron fittings, mechanical joints, cement-lined or fusion-bonded epoxy lining, coal tar epoxy or fusion bonded epoxy coating.
RCWR - Reclaimed Water Return RCW - Reclaimed Water	24	Below Ground	AWWA C150 and C151 ductile iron pipe, 200 psi pressure class, push-on joints, cement-lined, coal-tar epoxy coating, AWWA C110 ductile iron fittings, mechanical joint, cement lined or fusion-bonded epoxy lining, coal tar epoxy or fusion bonded epoxy coating.
RCWR - Reclaimed Water Return REJ - Reject RCW - Reclaimed Water	20	Below Ground	AWWA C150 and C151 ductile iron pipe, 250 psi pressure class, push-on joints, cement-lined, coal tar epoxy coating, AWWA C153 compact ductile iron fittings, mechanical joint, 350 psi pressure class, cement-lined or fusion bonded epoxy lining, coal-tar epoxy or fusion-bonded epoxy coating.
RECIRC - Reclaimed Water Recirculation BWW - Waste Backwash Water WM - Potable Water Main RCW - Reclaimed Water	4-12	Below Ground	AWWA C150 and C151 ductile iron pipe,, 350 psi pressure class, mechanical joints, cement-lined, coal-tar epoxy coating, AWWA C153 compact ductile iron fittings, mechanical joint, 350 psi pressure class, cement-lined or fusion-bonded epoxy lining, coal-tar epoxy or fusion-bonded epoxy coating.

WM – Potable Water Main	4 to 12	Below Ground	AWWA C900 PVC pipe, DR18, 150 psi working pressure, push-on joints, AWWA C153 compact ductile iron fittings, mechanical joint, 350 psi pressure class, cement-lined or fusion-bonded epoxy lining, coal-tar epoxy or fusion-bonded epoxy coating
NaOCL – Sodium Hypochlorite	½ - 2	Above Ground	Schedule 80 PVC pipe, solvent weld or flanged
	3 x 1	Below Ground	Double-contained Schedule 80 PVC pipe, 1-inch carrier, 3 inch containment, solvent weld
RCWR – Reclaimed Water Return	12	Inside Pump Station Wetwell	316 stainless steel, Schedule 10S, welded or flanged
RCW – Reclaimed Water	½ to 3	Above and Below Ground	Schedule 80 PVC Pipe, Solvent Weld or Flanged.
DR – Waste Backwash Drain from Filters to Pump Station Wetwell	2 to 6	Above and Below Ground	Schedule 40 PVC Pipe, Solvent Weld or Flanged.
SAM – Sample	½ - 3	Above and Below Ground	HDPE, DR9

PART 3 EXECUTION

3.01 DELIVERY, INSPECTION AND STORAGE

A. Inspect materials thoroughly upon arrival. Remove damaged or rejected materials from site.

B. Observe manufacturer's directions for delivery and storage of materials and accessories.

C. Store materials on-site in enclosures or under protective coverings above ground to keep them clean and dry.

3.02 HANDLING OF PIPE

A. Protect pipe coating during handling using methods recommended by manufacturer. Use of bare cables,

chains, hooks, metal bars, or narrow skids in contact with coated pipe is not permitted.

B. Prevent damage to pipe during transit. Repair abrasions, scars, and blemishes. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

C. Erect piping to accurate lines and grades and support as required on drawings or described in specifications. When temporary supports are used, ensure that sufficient rigidity is provided to prevent shifting or distortion of pipe. Install expansion devices, as necessary, to allow expansion and contraction movements.

3.03 PIPING - GENERAL

A. Minimum bury. Unless otherwise shown on the drawings, provide a minimum of 36-inches earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions.

3.04 PIPING WITHIN BUILDINGS, STRUCTURES AND UNITS

A. Install piping in vertical and horizontal alignment as shown on drawings. Alignment of piping smaller than 4-inches may not be shown. However, install according to drawing intent and with ample clearance and allowance for:

1. Expansion and contraction

2. Operation and access to equipment, doors, windows, hoists, moving equipment

3. Headroom and walking space for working areas and aisles

4. Install vertical piping plumb and horizontal piping runs parallel with structure walls

B. Use methods of piping support as shown on the drawings and as required in Section 15141 – Pipe Support Systems. Where pipes run parallel and as same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight. The pipe in the group requiring the least maximum distance

between supports shall set the distance between trapeze hangers.

C. Locate and size sleeves required for piping system. Arrange for chases, recesses, inserts, or anchors at proper elevation and location.

D. Install service piping to provide every plumbing fixture and equipment requiring potable water with suitable supply and soil or waste and vent connection as required by code. Consult manufacturer's data and large scale details of rooms containing plumbing fixtures before roughing in piping. Plug or cap piping immediately after installation.

E. Use reducing fittings throughout piping systems. Bushings will not be allowed unless specifically approved.

F. Provide drain pans and piping from items of equipment where condensation may occur. Run drain piping to nearest floor drain or rainwater downspout. Condensate drain piping shall generally be 1-inch except where otherwise indicated.

G. Soil, waste, vent and rainwater piping installation:

1. Install horizontal soil or waste lines with fall to produce flow rate of 2-feet per second or 1/8-inch per foot. Hold as close to construction as possible to maintain maximum headroom. Make changes of direction with 1/8 bends, and junctions with wye fittings. Use short wye fittings in vertical pipe only. Install handhold test tee at base of each stack. Install cleanouts at dead ends, at changes of direction, and at 50-foot intervals on horizontal runs. Where cleanouts occur in concealed spaces, provide with extensions to floors above or to wall as required.

2. Run vent stack parallel to each soil or waste stack to receive branch vents from fixtures. Each vent stack shall originate from soil or waste pipe at its base. Where possible, combine soil, waste, or vent stacks before passing through roof so as to minimize roof openings. Offset pipes running close to exterior walls away from such walls before passing through roof to permit proper flashing. Provide pipes passing through roofs with cast iron increases minimum of 12-inches below roof one size larger than pipe but in no case less

than 4-inches. Terminate each vent with approved frostproof jacket.

3. Provide each vent pipe passing through roof with 4-lb sheet lead flashing consisting of 18 x 18-inch base with tubular vertical sleeve surrounding pipe with 1-inch minimum spacing and turning in 2-inches at top. Provide gasket seal between top and lead sleeve.

4. Carry vent stacks 4-inches and larger full size through roof. Extend vent stacks at least 12-inches above roofing.

5. Provide each roof drain with 4-lb sheet lead flashing 36 x 36-inch square clamped under flashing ring of drain.

H. Potable or service water piping installation:

1. Install drain tees with capped nipples of PIS brass 3-inches long at low points. If low points occur in concealed piping, provide approved flush access panel. These drains are not shown on drawings.

2. Slope water lines down to drain points not less than 1-inch in 60-feet.

3. Wherever threaded piping is installed, provide clean-cut tapered threads with ends thoroughly reamed after cutting to remove burrs. Pipe joint cement permitted only on external threads. For screwed nipples for connections to flush valves, lavatory supplies, and other equipment with threaded connections use iron, copper, or brass pipe.

4. Install ball, butterfly, gate, check, and plug valves where indicated or required to adequately service all parts of system and equipment. Unless otherwise indicated, install valves on each branch serving restroom. Install valve on inlet and outlet connections of heat exchangers and on other equipment connected to water lines.

5. Install union between valves and connections to each piece of equipment and install sufficient number of unions throughout piping system to facilitate installation and servicing. On copper pipe line, install wrought copper solder-joint

copper to copper unions for lines 2-inches and smaller; for lines 2-1/2-inches and over, install brass flange unions.

6. Construct and equip plumbing fixtures and equipment with anti-siphon devices as to entirely eliminate any danger of siphoning waste material into potable water supply system.

7. Where exposed pipes 6-inches in size and smaller pass through floors, finished walls, or finished ceilings, fit with nickel or chrome-plated plates large enough to close hole completely around pipes. Secure plates to pipe by set screw in approved manner.

8. Size supply branches to individual fixtures as scheduled or indicated on drawings.

9. Install piping so as to be free to expand with proper loops, anchors, and joints with injury to system or structure.

10. Provide branches to wall hydrants or hose bibbs in exterior location with interior shutoff and drain valves.

11. Provide approved type vacuum breaker installations indicated or as required by Code.

3.05 PIPING OUTSIDE BUILDINGS AND STRUCTURES

A. Install piping as shown on drawings with ample clearance and allowance for expansion or contraction.

B. Install flexible joint within two (2) feet of point where pipe enters or leaves structure. Provide balance of piping with standard laying lengths and in accordance with drawings.

3.06 PIPE INTERSECTIONS WITH STRUCTURES AND UNITS

A. Enter and exit through structure walls by using wall seals specified or as shown on drawings.

3.07 EQUIPMENT PIPE CONNECTIONS

A. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at

connection or would cause unnecessary stresses to be transmitted to equipment flanges. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.

B. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint. Provide tightening torque in accordance with manufacturer's recommendations.

C. Support and match flange face to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.

D. Permit piping connecting to equipment to move freely in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened. Align, level, and wedge equipment into place during fitting and alignment of connecting piping. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange. Realign as necessary, install flange bolts, and make equipment connection.

E. Provide utility connections to equipment shown on drawings, scheduled or specified.

F. Obtain rough-in data from approved shop drawings on equipment. Obtain rough-in data for relocating existing equipment and coordinate with Owner.

G. Unless otherwise specified, make piping connections to equipment, including but not limited to installation of brass and fittings, strainers, pressure-reducing valves, flow control valves, and relief valves provided with or as an integral part of equipment.

H. Furnish and install sinks, brass, fittings, strainers, pressure-reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or an integral part of equipment.

I. For each potable or service water supply piping connection to equipment, furnish and install union and gate or angle valve. Minimum size to be 1/2-inch.

J. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system. Size trap as required by Plumbing Code.

K. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps, and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed. Run piping mains and branches in laboratory benches, built-in counters, and cabinet work if acceptable to Construction Manager.

3.08 ANCHORAGE AND BLOCKING

A. Block, anchor, or harness exposed piping subjected to internal pressure, in which mechanical, push-on, flexible, or similar joints are installed to prevent separation of joints.

B. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by internal pressure in buried piping tees, wye branches, plugs, or bends.

C. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall. Concrete blocks shall not cover pipe joints. Provide bearing area of concrete in accordance with drawing detail. In event that adequate support cannot be achieved against undisturbed soil, install restrained piping joints.

D. Provide reaction blocking, anchorages, or other supports for fittings as shown on drawings for piping installed in fills, unstable ground, above grade, or exposed within structures.

3.09 CLEANING

A. Clean interior of piping systems thoroughly before installing. Maintain pipe in clean condition during installation.

B. Before jointing pipe, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.

C. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.

D. At completion of work and prior to final acceptance, thoroughly clean work installed under these specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.

3.10 PIGGING, FLUSHING AND CLEANING

A. All mains and distribution lines shall be pigged, cleaned and flushed to remove all sand and other foreign matter. The Contractor shall be responsible for developing a pigging and flushing plan to be submitted to the Engineer for approval prior to pigging and flushing. The contractor shall dispose of all water used for pigging and flushing without causing a nuisance or property damage. Any permits required for the disposal of flushing water shall be the responsibility of the Contractor.

B. Flushing water used by the Contractor shall be taken from an approved metered source. The water utility will provide the meter and designate the source. Flushing water shall be at the Contractor’s expense. Flushing water shall be potable water for potable water mains.RCW mains may be flushed with potable or reclaimed water.

C. The cleaning of the new piping system shall be accomplished by the controlled and pressurized passage of a series of hydraulic or pneumatic polyurethane plugs of varying dimensions, coatings, and densities; which shall be selected by the pipe cleaning Contractor. The Contractor shall provide a means to enter the pig into the system, control and regulate flow, monitor flows and pressures, and to remove the pig from the system. The contractor shall maintain a constant surveillance of the system and immediately report to the proper authority any inline problems

encountered or any malfunctions discovered in the piping system. A record of pig models, sizes, styles, and other pertinent information shall be kept by the Contractor and turned over to the Owner

3.11 TESTING AND INSPECTION

E. Upon completion of piping, but prior to application of insulation on exposed piping, test all piping systems. Utilize pressures, media and pressure test duration at specified on piping specification sheets. Isolate equipment which may be damaged by the specified pressure test conditions. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates. Select each gage so that the specified test pressure falls within the upper half of the gage's range. Notify the Engineer 24 hours prior to each test.

F. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.

G. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.

H. Provide all necessary equipment and perform all work required in connection with the tests and inspections.

I. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

3.12 DISINFECTING POTABLE WATER PIPELINES

A. All record drawing requirements must be submitted to the Owner/Engineer prior to starting the bacteriological testing of the water lines.

B. Prior to being placed in service, all potable water pipe lines shall be chlorinated in accordance with AWWA 651, “Standard Procedure for Disinfecting Water Main”. The procedure shall meet Health Department requirements. The location of the chlorination and sampling points shall be determined by the Engineer. Taps for chlorination and sampling shall be uncovered and backfilled by the Contractor as required.

C. The general procedure for chlorination shall be to flush all dirty or discolored water from the lines, and then introduce chlorine in approved dosages through a tap at one end while water is being withdrawn at the other end of the line. The chlorine solution shall remain in the pipe line for 24 hours.

Water for flushing, filling and disinfecting the new lines will be provided by the owner and must be obtained without contaminating existing pipe lines. Water obtained from existing pipe lines for this purpose shall pass through an approved air gap or backflow prevention device.

D. Following the chlorination period, all treated water shall be flushed from the lines at their extremities and replaced with water from the distribution system. Bacteriological sampling (taken by the Contractor and provided to an approved laboratory by the Contractor) and analysis of the replacement water shall then be made by an approved laboratory or the Health Department in full accordance with the AWWA Manual C651. The line shall not be placed in service until the requirements of the Florida Department of Environmental Protection (FDEP) and County Public Health Department are met. Results of the bacteriological tests together with certified record drawings must be submitted to the Health Department (FDEP) within 30 days of the tests.

E. Special disinfecting procedures when approved by the County may be used where the method outlined above is not practical.

3.13 LOCATION OF BURIED OBSTACLES

J. Furnish exact location of buried utilities encountered and any below grade structures. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants, and related fixed structures. Include such information as location, elevation, coverage, supports, and additional pertinent information which will be required by future contractors for replacement servicing, or adjacent construction around any buried facility.

K. Incorporate information to "Record Drawings".

3.14 SPECIAL REQUIREMENTS AND PIPING SPECIALTIES

L. Insulating joints: Provide insulating joints where dissimilar metals are joined together and where specifically indicated on drawings. Type of joint shall be as detailed and in accordance with the following requirements:

1. Insulating flanges: Provide each unit to consist of flat-faced rubber gaskets.

2. Insulating unions: Provide "dielectric" union by Epco or equal.

3. Insulating couplings: When joining larger diameter dissimilar metal pipe, use insulating coupling equal to Rockwell No. 416, Dresser Style 39, or equal. When pipes have different outside diameters, use insulating reducing couplings equal to Rockwell No. 417, Dresser Style 39-62, or equal.

M. Welding:

1. Have each welding operator affix an assigned symbol to all his welds. Mark each longitudinal joint at the extent of each operator's welding. Mark each circumferential joint, nozzle, or other weld in two places 180˜F apart.
2. Use only certified welders meeting procedures and performance outlined in Section 9 of the ASME other codes and requirements per local building and utility requirements.

3. Have all welds conform to highest industrial practice in accordance with ANSI B31.3 and ANSI B31.1 or other codes and requirements per local building and utility requirements.

N. Protective coatings and linings:

1. Where coatings, linings, paint, tests and other items qualified in applications of service are stated, pipe and fittings shall be included in referenced conditions.

2. Where specified, provide coal-tar epoxy linings and coatings in accordance with AWWA C210 to a minimum thickness of 20 mils in not less than two coats.

3. Where specified, provide cement mortar lining in accordance with AWWA C205.

4. Where specified, provide Protecto 401 lining.

5. Where specified, galvanize surface in accordance with hot-dip method using any grade of zinc acceptable to ASTM B6.

6. Where specified, field paint pipe in accordance with Section 09900 – Painting and Coatings and Section 09902 – Pipe and Equipment Painting.

O. Underground alarming tape. Provide underground warning tape constructed of heavy gage 0.004-inch polyethylene film to identify all buried utilities except 3-inch and smaller irrigation pipe. Provide 6-inch wide tape as follows:

Film Legend	Film Color
Electric line below	Red
Telephone line below	Orange
Water line below	Blue
Sewer line below	Green
Nonpotable water below	Brown
Reclaimed Water Below	Purple

P. Install tape directly above each buried utility as shown on the Drawings.

END OF SECTION