

SAUSALITO-MARIN CITY SANITARY DISTRICT
Marin County, California

CONTRACT DOCUMENTS

FOR THE CONSTRUCTION OF THE



TREATMENT AND WET WEATHER FLOW UPGRADES

PROJECT NO. 0055-006

Volume 2
Specifications Divisions 02 - 16

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CONFORMED SPECIFICATIONS

MARCH 2017



In Association with

TJC and Associates, Inc.
DTN Engineers

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RMC Water and Environment
2175 North California Blvd., Suite 315
Walnut Creek, CA 94596

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TREATMENT AND WET WEATHER FLOW UPGRADE PROJECT

TABLE OF CONTENTS

Response to Bidder Questions Issued in Addendum No. 2

Division 0 - BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS

BIDDING REQUIREMENTS AND DOCUMENTS

Notice Inviting Bids
Instructions to Bidders
Bidder's Check List
Bid Label
Bid
Non Collusion Affidavit
Bid Bond
Contractor's License Information
Designation of Subcontractors and Electrical Subcontractor Bonding Profile
Major Equipment and Material Suppliers, Products Identified by Name and Substitution
Worker's Compensation Insurance Certification
Debarment Certification
Bidder's Signature Page

CONTRACT REQUIREMENTS AND DOCUMENTS

Contract Check List
Agreement
Performance Bond
Payment/Labor and Materials Bond
Maintenance Bond
Escrow Agreement for Security Deposits in Lieu of Retention

GENERAL CONDITIONS

DIVISION 01 - GENERAL REQUIREMENTS

01010 Summary of Work
01014 Protection of Environment
01025 Measurement and Payment
01030 Special Constraints
01040 Coordination, Work Sequence and Constraints
01060 Safety and Regulatory Requirements
01300 Submittals
01301 Schedule of Values
01310 Progress Schedules
01353 Hazardous Materials (Soil and Groundwater)
01400 Quality Control
01500 Construction Facilities and Temporary Controls
01600 Delivery Storage and Handling
01612 Seismic Design Criteria
01614 Wind Design Criteria
01650 Facility Start Up
01700 Contract Close Out
01720 Record Documents
01730 Operating and Maintenance Data
01740 Warranties

DIVISION 02 - SITEWORK

- 02050 Demolition & Reconstruction
- 02081 Hazardous Materials Abatement
- 02100 Site Preparation & Plant Protection
- 02140 Dewatering
- 02200 Earthwork
- 02210 Controlled Low Strength Material
- 02286 Soil Nails
- 02390 Shoring
- 02460 Asphalt Concrete Pavement and Base
- 02500 Buried Pipe Installation
- 02510 FRP Ductwork
- 02540 Precast Concrete Manholes and Drop Inlets
- 02565 Ductile Iron Pipe (AWWA C151, Modified)
- 02571 Steel Pipe, Mortar Lined and Mortar Coated (AWWA C200, Modified)
- 02590 High Density Polyethylene Pressure Pipe
- 02595 Polyvinyl Chloride Non-Pressure Pipe, Rubber Joints (ASTM D3034 and F679, Modified)
- 02597 Polyvinyl Chloride Pressure Pipe, Rubber Joints (AWWA C900, Modified)
- 02600 Importing Soils and Fill Materials
- 02620 Hydraulic Structure Testing and Disinfection
- 02640 Pipeline Testing
- 02700 Precast Trench Drains
- 02810 Irrigation
- 02822 Vinyl Bond Chain Link Fencing
- 02870 Site Furnishings
- 02900 Planting

DIVISION 03 - CONCRETE

- 03100 Concrete Formwork
- 03150 Concrete Joints and Joint Accessories
- 03200 Concrete Reinforcement
- 03300 Cast-In-Place Concrete
- 03360 Shotcrete and Wall Drainage
- 03380 Concrete Electrical Duct Encasement
- 03600 Grout
- 03740 Modification and Repair to Concrete

DIVISION 04 - MASONRY (NOT USED)**DIVISION 05 - METALS**

- 05120 Structural Steel
- 05500 Miscellaneous Metals
- 05510 Metal Stairs
- 05520 Aluminum Handrails and Railings
- 05530 Landscape Metalwork

DIVISION 06 - WOODS AND PLASTICS

- 06620 PVC Liners

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

- 07190 Water Repellents
- 07600 Flashing and Sheet Metal
- 07920 Joint Sealants

DIVISION 08 - DOORS AND WINDOWS

- 08254 Pre-Assembled Plastic Door Assemblies
- 08710 Door Hardware
- 08800 Glazing

DIVISION 09 - FINISHES

- 09960 Protective Coatings
- 09970 Shop Painting of Hot-Dipped Galvanized Steel

DIVISION 10 - SPECIALTIES

- 10400 Identifying Devices

DIVISION 11 - EQUIPMENT

- 11000 Equipment General Provisions
- 11052 Automated Refrigerated Samplers
- 11100 Pumps, General
- 11136 Vertical Non-Clog Pumps
- 11141 Recessed Impeller Pumps
- 11147 Double Disc Sludge Pumps
- 11148 Submersible Non-Clog Pumps
- 11231 Circular, Center-Feed Clarifiers
- 11305 Horizontal Self-Priming Pumps
- 11320 Hydraulic Grit System
- 11325 Grit Washer
- 11330 Filter Screens
- 11403 Fixed Film Reactor (FFR) Media
- 11606 Digester Gas Handling Equipment
- 11690 Fuel Storage Tank
- 11800 Disk Filter System
- 11900 Flushing Trough

DIVISION 12 - FURNISHINGS (NOT USED)**DIVISION 13 - SPECIAL CONSTRUCTION**

- 13115 Corrosion Protection System
- 13130 Flat Circular Clarifier Covers
- 13200 Dumpster Bin
- 13400 Instrumentation and Control System
- 13470 SCADA PLC System
- 13475 Control Strategies
- 13480 I/O list
- 13481 Packaged Equipment IO List
- 13482 Instrument Index

DIVISION 14 - CONVEYING SYSTEMS

- 14510 Shaftless Screw Conveyors
- 14600 Hoist, Cranes, and Winches, General
- 14700 Turntable

DIVISION 15 - MECHANICAL

- 15000 Piping, General
- 15005 Piping Identification Systems
- 15006 Pipe Supports
- 15025 Steel Pipe
- 15030 Stainless Steel Pipe
- 15036 Copper Pipe
- 15060 Polyvinyl Chloride Solvent-Welded Pipe
- 15061 Double Containment Tubing
- 15086 Parshall Flume
- 15180 Strainers
- 15200 Valves, General
- 15201 Valve and Gate Actuators
- 15203 Check Valves
- 15214 Pressure Relief Valves
- 15230 Misc Valves
- 15250 Hydraulic Gates and Valves, General
- 15430 Plumbing and Piping
- 15870 Fiberglass Reinforced Plastic (FRP) Ducting
- 15954 HVAC Systems Testing, Adjusting, and Balancing
- 15955 Exhaust Fans

DIVISION 16 - ELECTRICAL

- 16000 Requirements for Electrical Work
- 16025 Electrical Demolitions and Modifications
- 16075 Electrical Identification
- 16123 600 Volt or Less Wires and Cables
- 16134 Boxes
- 16145 Cabinet and Enclosures
- 16148 Disconnect Switches
- 16153 Low Voltage Circuit Breakers
- 16155 Motor Control
- 16159 Panelboards
- 16160 Lighting
- 16222 Motors
- 16262 Variable Frequency Drives Below 100 Horsepower
- 16720 Fire Alarm System
- 16860 Installation of Packaged Equipment
- 16920 600 V Motor Control Center
- 16921 Power Quality Equipment
- 16938 Power System Study
- 16940 Electrical Testing

SECTION 02050 – DEMOLITION & RECONSTRUCTION

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish all materials, supplies, tools, equipment, and labor as required for the reconstruction of all or portions of existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as specified herein and/or shown on the Drawings.
- B. Reconstruction shall include, but shall not be limited to, the following items:
 - 1. Demolition
 - 2. Salvage
 - 3. Relocation
 - 4. Abandonment
 - 5. Rehabilitation
 - 6. Disposal
- C. Related Work Specified Elsewhere
 - 1. Section 01010 - Summary of Work
 - 2. Section 01300 - Submittals
- D. The Contractor shall carefully coordinate the reconstruction in areas where existing facilities are interconnected with new facilities and where existing facilities shall remain operational. The reconstruction specified and shown in the Contract Documents is not all inclusive and the Contractor shall be responsible to perform the reconstruction specified, shown, or which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with Project and operational sequencing requirements specified in Section 01010 - Summary of Work.
- E. The Contractor shall note that the Drawings used in this Contract to indicate reconstruction are based on design drawings for the existing facilities. The plans and sections depicted in the Contract Documents have been reproduced to show existing conditions and to clarify the scope of work as much as possible. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Project Site of the facilities to verify the correctness and exactness of the Drawings, the scope of work, and the extent of auxiliary utilities. A set of design drawings is available for review at the Project site.
- F. While reconstruction is being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes.

The Contractor shall erect and maintain fences, warning signs, barricades, and other devices as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove all such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

1.2 CONTRACTOR SUBMITTALS

- A. Reconstruction activities and procedures, including operation sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities that are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection of utility service. The storage plan for all salvaged items shall be included. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. Submittals shall be in accordance with Section 01300 - Submittals.

PART 2 PRODUCTS

2.1 GENERAL

- A. Demolition: Existing pavement, structures, equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware shown or required to be demolished as part of the Work shall be removed and disposed of by the Contractor unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Items to be removed shall be disposed of offsite by the Contractor as part of the Work.
- B. Salvage: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be salvaged shall be removed by the Contractor. Materials and equipment to be salvaged shall be removed in a manner that maintains them in a condition equivalent to their condition prior to being removed. Salvaged items shall be stockpiled and protected on the jobsite by the Contractor at a location directed by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling. The Contractor shall coordinate with the Owner during construction with regard to equipment to be salvaged.
- C. Relocation: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be relocated shall be removed and reinstalled by the Contractor. Materials and equipment to be relocated shall be removed in a manner that maintains them in a condition equivalent to their condition prior to being removed. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.
- D. Abandonment: Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances shown to be abandoned in place shall be protected from damage as specified herein and shown on the Drawings. Pipelines that are to be cut and abandoned in place shall be capped unless otherwise indicated.

- E. Remove: "Remove" shall be defined as "Demolition" and "Disposal" by the Contractors unless otherwise noted.
- F. Rehabilitation
 - 1. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as specified herein and shown on the Drawings at the Contractor's expense.
 - 2. Damaged items shall be repaired or replaced with new materials as required to restore damaged items of surfaces to a condition equal to and matching that existing prior to damage or start of work of this Contract.
 - 3. In buildings with reconstruction work, the Contractor shall not use any Owner equipment (e.g., bridge cranes and monorails) unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the loading he proposes to place on the equipment and subject to Owner requirements for crane use for operating and maintenance needs. Any damage sustained in the use of a crane by the Contractor shall be repaired or replaced at no cost to the Owner. The damaged unit shall be repaired or replaced as described above.
- G. Disposal: The Contractor shall be responsible for the offsite disposal of all debris resulting from reconstruction in compliance with all local, state, and federal codes and requirements. Debris resulting from reconstruction includes, but is not limited to, all concrete masonry, metals, asphalt, equipment, liquids that are required to be drained, solids that require removal, wires, cables, conduits, and miscellaneous material resulting from demolition, salvage, relocation, abandonment, and rehabilitation activities and procedures.

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for the coordination of reconstruction work with the Owner and Engineer. Unless otherwise specified or shown, the Contractor shall be responsible for the sequence of reconstruction activities. All reconstruction shall be performed in accordance with applicable safety rules and regulations.
- B. The Contractor shall ensure that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned shall be inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with reconstruction.
- C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the reconstruction activities to the extent specified and shown. If reconstruction beyond the scope specified or shown is required, the Contractor shall obtain written approval from the Engineer prior to commencing work.
- D. Explosives shall not be permitted for demolition.

3.2 INSTALLATION

A. Protection of Existing Facilities

1. Before beginning any reconstruction work, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained. Damage to existing facilities shall be repaired or replaced to its existing condition at no additional cost to the Owner.
2. Contractor shall ensure the safe passage of persons around area of demolition.
3. The existing elevated causeway next to the existing primary clarifier, along the shoreline, has a weight limitation of 250 pounds per square foot, maximum.
4. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for shoring, bracing, or adding new supports as may be required to ensure adequate structural support as a result of any reconstruction work performed under any part of this Contract. The Contractor shall remove all temporary protection when the Work is complete or when so authorized by the Engineer.
5. The Contractor shall carefully consider all bearing loads and capacities for placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

B. Demolition, Salvage, Relocation

1. The Contract drawings identify existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utility services such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated or shown. The Contractor shall verify the scope of the work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01300 - Submittals. The removal of existing facilities for demolition, salvage, and relocation shall include, but not be limited to, the following requirements at no addition cost to the Owner:
 - a. All equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Any damage to the existing structure shall be repaired as specified.
 - b. All exposed piping (including vents and drains) and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2 inches. All resulting openings in the structure shall be repaired as specified herein.
 - c. All electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
 - d. All exposed electrical conduits and associated wiring shall be removed. All resulting openings in structures shall be repaired as specified herein.

- e. Embedded electrical conduits shall be removed a minimum of 2 inches from the finished surface of the existing structure. All wiring shall be removed within the existing structure and the resulting openings shall be repaired as specified herein.
 - f. All associated instrumentation devices shall be removed.
 - g. All auxiliary utility support systems shall be removed.
 - h. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
- 2. Asphalt and concrete pavement, curbs and gutters shall be removed as necessary to perform construction. The limits of removal shall be saw cut in neat clean lines. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be replaced to match the original unless otherwise specified or shown.
 - 3. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth that will not interfere with new construction, but not less than 36 inches below existing ground surface or future ground surface, whichever is lower, unless otherwise stated in this Section or shown on the Drawings.
 - 4. Below-grade areas and voids resulting from demolition of pipes and structures shall be completely filled. All fill and compaction shall be in accordance with Section 02200 – Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as shown.
 - 5. When existing pipe is cut or removed, the Contractor shall plug or cap all resulting open ends whether or not shown. Where remaining piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug. If the existing piping is to remain in service, all blind flanges, plugs, and/or caps shall be gasketed where applicable and leak tight for the existing pipes service conditions. The Contractor shall use fittings that are specifically designed for the existing pipe. Contractor shall provide thrust protection as required.
 - 6. When existing piping is removed from existing structures, the Contractor shall fill in resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or shown to prevent leakage from the structure for the service conditions of the structure. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to approximately 1/2-inch from the exposed surface and the recessed area filled with cement mortar grout.
 - 7. All electrical reconstruction shall be conducted by the Contractor in a safe and proper manner at all times to avoid injury from electrical shock to the Owner's and Contractor's personnel. Prior to electrical reconstruction, the Contractor shall notify the Owner in writing a minimum of 5 days prior to requested de-energization. The Owner shall de-energize and safe-out the equipment. Both the Contractor and Owner shall use lock-out/tag-out procedures on equipment.

Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall live electrical wiring or connections or those which can become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

8. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its operating condition immediate prior to relocation at no expense to the Owner.
9. Facilities known to contain hazardous materials are identified in Section 02081 – Hazardous Materials Abatement. Contractor shall demolish and dispose of hazardous materials in accordance with Section 02081.
10. Digester Gas Scrubber/Purifier Media Removal and Disposal
 - a. Gas scrubber contains iron sponge media which contains:
 - 1) Iron Oxide
 - 2) Elemental Sulfur
 - 3) Wood Fiber
 - 4) Water
 - 5) Soda Ash
 - 6) Limestone
 - b. As used (spent) media is exposed to the atmosphere, it must be thoroughly soaked with water. This excess water initiates the regeneration process (using the dissolved oxygen in the water). It also dissipates the heat that is given off by the reaction of the Iron Sulfide with the oxygen in the atmosphere to reduce the possibility of combustion. Open flames, spark-producing procedures, cigarette smoking, etc. are NOT permitted at any time.
 - c. Contractor shall wear NIOSH approved dust masks, non-absorbent safety gloves, and OSHA approved safety glasses or goggles, during the removal of the gas scrubber media.
 - d. Gas scrubber media must be regenerated on-site prior to hauling for disposal per the following procedure:
 - 1) Remove gas scrubber media from the gas scrubber using a clamshell bucket, backhoe, shovel, etc. and spread over a concrete bed outdoors to a depth of 6-8 inches.
 - 2) Sprinkle regularly with a water hose to keep sponge thoroughly soaked with water. All runoff shall be collected and disposed of to the treatment plant.

- 3) At one to two day intervals turn the iron sponge material over with a fork in a windrow so that all surfaces are exposed thoroughly to the air. Allow media to react with the air for a minimum of ten (10) days, which is in accordance with Department of Transportation (D.O.T) procedure number 173.174, par. C.
 - 4) When the media resumes a brown color and no more heat is being given off, the regeneration process (oxidation) is complete.
- e. Contractor shall dispose of the media after regeneration is complete. In urban areas the material is generally accepted with EPA approval at a sanitary landfill. The Contractor shall haul the regenerated media in accordance with D.O.T procedure number 173.174, par. C.

C. Abandonment

1. Existing facilities to be abandoned shall be prepared as specified herein or shown on the Drawings. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5 feet from any connecting structures unless otherwise noted on the drawings. All openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inch diameter or greater, shall be completely sand-filled prior to closure of the piping ends.

D. Rehabilitation

1. Certain areas of existing structures, piping, conduits, and the like will be affected by work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by the construction activities.
2. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw cutting clean straight lines to a minimum depth of 1 inch and then chipping out the concrete. Alternately, the sides of the opening (not the corners) can be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1 inch (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. All necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2 inches from the finished face of the new opening and painted with epoxy paint. The inside face of the new opening shall be grouted with an epoxy cement grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.

3. Where existing rectangular openings are to be filled in concrete walls, the openings shall be filled with non-shrink grout and finished to match the adjacent area. The openings shall have a slight (45 degree) flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.
4. When new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as shown or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to ensure watertightness around openings so formed. The cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.
 - a. The pipes, castings, or conduits, as specified, shall be grouted in place by pouring in grout under a head of at least 4 inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouting casings shall then be water cured.
 - b. In all locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed to 1/2-inch back of the exposed surface and the recessed area filled with cement mortar grout.
5. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection shown. Any damage to the lining and coating of the existing piping shall be repaired by the Contractor. Dielectric insulating joints shall be installed at interconnections between new and existing piping.
6. Where existing equipment, equipment pads and bases, piping, piping supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads and bases for equipment and supports shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2 inches below finished grade and shall be coated with Sikadur 31 Hi-Mod Gel or equal in accordance with Section 09960 – Protective Coatings. . The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1-1/2-inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit. Existing pipes plugged with grout shall have grout penetrate to 2 feet into the pipe.

7. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete.
 - a. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.
 - b. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2 inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.
8. Where existing handrailing is removed, post embedments and anchors shall be cut flush at the concrete surface, post holes shall be filled with non-shrink grout flush to the floor surface and exposed embedments and anchors shall be coated with Sikadur 31 Hi-Mod Gel or equal in accordance with Section 09960 – Protective Coating. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.
9. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated to match the original painting and coating with a compatible system in accordance with Section 09960 – Protective Coatings. Equipment items that are relocated shall be completely surface prepared and coated in accordance with Section 09960 – Protective Coating.
10. The Drawings identify the major equipment and structures to be demolished. Auxiliary systems such as water, auxiliary equipment, drainage, electrical wiring, controls, and instrumentation are not necessarily shown. In association with the electrical equipment demolition, the following work shall also be performed at no additional cost to the Owner.
 - a. All auxiliary utility support systems to facilitate proper operation of the plant shall remain in service except when auxiliary systems are identified for demolition in which case the systems may be decommissioned in accordance with sequencing and constraints in Section 01040. Auxiliary utility support systems include but are not limited to water, ventilation, lighting, and sump pumping. Temporary provisions may be made to maintain such systems during switchover.
 - b. During construction, electrical systems shall be maintained as required to support auxiliary utility support systems. These systems can and will be a combination of existing, temporary, and new items. All demolition work shall be performed in a manner and sequence to ensure continued operation of these auxiliary systems.
 - c. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
11. Where existing materials and equipment are removed or relocated, remove all materials no longer used such as studs, straps, conduits, and wires. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least 2 inch below the final finished surface.

E. Disposal

1. Demolition and removal of debris shall be conducted to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.
2. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of at the Contractor's expense. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.
3. The use of burning at the project site for the disposal of refuse, debris, and waste materials resulting from demolition and site clearing operations will not be permitted.

F. Occupancy and Pollution Control

1. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. Comply with all government regulations and Contract Documents requirements pertaining to environmental protection.
2. Water shall not be used when it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

G. Cleaning

1. During and upon completion of work, the Contractor shall promptly remove unused tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by work in a clean, approved condition.
2. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas returned to condition existing prior to start of work.
3. The Contractor shall clean and sweep the street and road in accordance with Division 1.

END OF SECTION

SECTION 02081 – HAZARDOUS MATERIALS ABATEMENT

PART 1 GENERAL

1.1 DESCRIPTION

- A. The work of this section includes removal, clean up and disposal of the below listed hazardous materials to the extent necessary for the building and structure demolition work of the project. These work scope items are generally described as follows for the buildings and structures indicated. Contractor is to review all demolition plans and field verify location and extent of hazardous materials related work.
1. Filter Press Building (also referred to as Dewatering Building)
 - a. Exterior wall panels are manufactured of asbestos cement (transite)
 - b. Drywall/tapping and mud contained detectable levels of asbestos
 - c. Lead based paint was detected on the white metal I-beams at the bottom of the Filter Press Building
 - d. Suspected mercury containing fluorescent light tubes were observed in the Filter Press Room.
 - e. Due to the age of the structure, light fixture ballasts may contain polychlorinated biphenyls (PCB's)
 2. Fixed Film Reactor (FFR) Pumps
 - a. Gasket material contains asbestos
 3. Sand Filter Area
 - a. Gasket material contains asbestos
 - b. Lead based paint was detected on the green metal valves and pumps in the Sand Filter Pump Area
 - c.
 4. Plant Access Stairs (on the west side of the existing primary clarifier)
 - a. Lead based paint was detected on the gray metal stair stringer and railing posts
- B. Contractor shall review the demolition plans, related documents identified herein, and shall visit the site during the scheduled bid walk and field verify the location and extent of hazardous materials removal work prior to submitting bid.
- C. The Contractor's work scope includes all removal, waste testing, transportation and disposal or recycling costs associated with removed materials and removal operations.
1. Removed asbestos is to be disposed of as non-hazardous asbestos waste;
 2. Removed paint chip wastes are to be disposed of as RCRA lead hazardous wastes;
 3. PCB ballasts and transformers are to be disposed of as hazardous PCB wastes;

4. All remaining hazardous materials wastes, including lighting tubes and lamps, batteries, and other universal wastes are to be recycled by a permitted facility or disposed of as hazardous wastes.
 5. Unless otherwise noted, remove any other hazardous materials such as solvents, paints, adhesives, lubricants, fuels, etc. and recycle or dispose of in accordance with applicable regulations.
- D. The Contractor's work scope also includes all required lead-related protective measures for Cal/OSHA and Cal/EPA compliance associated with demolition of buildings, structures or other components on this site.

1.2 RELATED DOCUMENTS

- A. Hazardous Material Pre-Demolition Inspection and Bulk Sampling Various Structures at the Sausalito-Marín City Treatment Plant, dated December 17, 2014, prepared by NorBay Consulting
- B. Project Drawings including site plan and demolition drawings.

1.3 REFERENCES

- A. General: Codes, regulations, and references to hazardous materials abatement work include, but are not limited to the most current versions of the following:
 1. California Code of Regulations (CCR):

Title 8; Article 2.5 Title 8, Section 1529 Title 8, Section 1531 Title 8, Section 1532.1 Title 17, Div. 1, Ch. 8 Title 22, Div. 4, Ch. 30 Title 22, Div. 4.5, Ch 23	Registration Asbestos-Related Work Construction Safety Orders, Asbestos Regulations. Construction Safety Orders, Respiratory Protection Construction Safety Orders, Lead in Construction Accreditation, Certification, and Work Practices for Lead-Based Paint and Lead Hazards Minimum Standards for Management of Extremely Hazardous Waste Universal Waste Rule
 2. Bay Area Air Quality Management District (BAAQMD):

Regulation 11, Rule 2	Asbestos Demolition, Renovation and Manufacturing
- B. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes and regulations.

1.4 DEFINITIONS

- A. Definitions specific to Work of this Section:
 1. Abatement -- Procedures to control airborne contaminate and other releases from hazardous material-containing building materials. Includes removal, repair, encapsulation, and enclosure.

2. Airlock -- A system for permitting ingress and egress with minimum air movement between a contaminated area and an uncontaminated area.
3. Air Monitoring -- The processing of measuring the air contaminants such as asbestos or lead for measured volume of air collected over the specific period of time being monitored.
4. Air Sampling Professional -- The professional contracted or employed to supervise air monitoring and analysis schemes. This individual is also responsible for recognition of technical deficiencies in Worker protection equipment and procedures during both planning and on-site phases of an abatement project.
5. Amended Water -- A water to which a surfactant has been added.
6. Asbestos -- The term asbestos includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
7. Asbestos Containing Construction Material (ACCM) -- Any construction material with asbestos content of 0.1 percent or greater by weight.
8. Asbestos Containing Material (ACM) -- Any material which contains over one percent asbestos as determined by current EPA bulk sample analysis method.
9. Asbestos Fibers -- This expression refers to asbestos fibers longer than five micrometers with an aspect ratio of 3:1 or larger under phase contrast microscopy (PCM) analytical procedures.
10. Authorized Visitor -- Any Owner Representative, Consultant or Agent and any representative of a regulatory of other agency having jurisdiction over the project.
11. Certified Supervisor -- An individual who is capable of identifying asbestos or lead hazards in the workplace and who has sufficient experience and authority to take prompt corrective measures to eliminate them. In addition, the Certified Supervisor is responsible for conducting and approving all required inspections as specified. Also known as the "Competent Person."
12. Class I Asbestos Removal -- Class I Asbestos work means activities involving the removal of thermal system insulation (TSI) and surfacing ACM.
13. Class II Asbestos Work -- Class II Asbestos Work means activities associated with removal of any asbestos containing material that is not a Class I surfacing material or thermal system insulation. This includes but is not limited to, removal of resilient flooring materials, roofing materials including sealants, and caulking materials.
14. Clean Room -- An uncontaminated area or room that is a part of the Worker decontamination enclosure with provisions for storage of Workers' street clothes and protective equipment. .
15. Critical Barrier -- A unit of temporary construction of air-tight and impermeable barrier which provides the only separation between a contained asbestos Work Area and an adjacent, potentially occupied area.

16. Decontamination Enclosure System -- A series of connected rooms, with air-tight doorways between any two adjacent rooms, for the decontamination of Workers and of materials and equipment. A decontamination enclosure system always contains at least one airlock.
17. Differential Pressure Equipment -- A portable local exhaust system equipped with HEPA filtration and capable of maintaining a constant, low velocity air flow into contaminated area from adjacent uncontaminated areas. Also referred to as HEPA Exhaust Units or Negative Pressure Units (NPU's).
18. Encapsulant (sealant) -- A liquid material which can be applied to asbestos containing material or surface and which controls the possible release of asbestos fiber from the material or surface by creating a membrane over the surface (bridging encapsulant), or by penetrating into the material and binding its components together (penetrating encapsulant), or by locking down invisible fibers (lockdown encapsulant).
19. Fluorescent Light Ballast (FLB) -- A device that electrically controls fluorescent light fixtures. Most existing FLBs include a capacitor containing 0.1 kilograms or less of dielectric fluid that may contain PCBs. Ballasts manufactured prior to 1979 may contain PCB capacitors. More recently, electronic ballasts have come into use that do not have dielectric fluids or PCBs. Ballasts with PCB capacitors also contain asphalt potting compounds which are likely to contain PCBs.
20. Hazardous Materials -- hazardous materials include, but are not limited to: asbestos containing materials, lead and lead-based paint, mercury, PCB, coolant gases, universal wastes, solvents, fuels and other chemical products or wastes.
21. HEPA Filter -- A high-efficiency particulate absolute (HEPA) filter capable of trapping and retaining 99.97 percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.
22. HEPA Vacuum Equipment -- Vacuuming equipment with a HEPA (UL 586 labeled) filter system.
23. Lead-Based Paint (LBP) - Lead-Containing Paint (LCP) that is at least 0.5% lead by weight or 1.0 milligrams of lead per square centimeter of surface area (as measured by XRF lead analyzer). Note: any untested paints or coatings must be presumed to be LBP.
24. Lead Hazardous Waste -- Lead-based paint waste or other debris that has been classified as hazardous due to the characteristic of toxicity, as determined by testing in accordance with the California Code of Regulations, Title 22, Division 4, Chapter 30, Article 11. A hazardous waste is any substance(s) listed in Article 11 Section 66699 at concentrations greater than its listed Soluble Threshold Limit Concentration (STLC) or Total Threshold Limit Concentration (TTLC). The STLC for lead is 5.0 parts per million (ppm) and the TTLC for lead is 1000 ppm lead. If either of these values are exceeded, the lead related waste will need to be further characterized by the Toxicity Characteristic Leaching Procedure (TCLP) in accordance with 40 CFR 261 and possibly other tests prior to disposal as a

hazardous waste. Waste testing for proper disposal is the responsibility of the Contractor.

25. Negative Pressure Enclosure (NPE) -- An enclosed or contained area of any configuration constructed of polyethylene sheeting with a minimum of four (4) air changes per hour and a negative pressure of -0.02 inches of water as compared to surrounding areas outside the enclosure. NPE must be maintained until final air clearance sampling.
26. Non-Friable Asbestos Material -- Material that contains asbestos in which the fibers have been locked in by a bonding agent, coating binder, or other material so that the asbestos is well bound and will not release fibers in excess of the asbestos control limit during any appropriate use, handling, demolition, storage, transportation, processing, or disposal.
27. Non-hazardous Asbestos Waste -- Wastes which are non-friable and/or are below one percent asbestos by weight as determined by objective testing. These wastes require OSHA Asbestos Hazard warning labels and disposal at landfills that accept such asbestos wastes.
28. Observation Service -- Environmental Consultant hired to conduct compliance observation and air monitoring services on behalf of the Owner. Sometimes referred to as the Owner's Observation Service.
29. Polychlorinated Biphenyl (PCB) -- PCBs are any chemical substances consisting of the biphenyl molecule chlorinated to varying degrees or any combination of such molecules. PCBs have had a wide variety of uses in the past including dielectric fluids in capacitors. PCBs are clear to yellow oily substances which are toxic to the liver and reproductive system. PCBs are also suspect human carcinogens.
30. PCB Ballast -- An FLB that is known or suspected to contain PCBs. All FLBs must be considered PCB ballasts unless they are:
 - a. Labeled or marked "No PCB" by the manufacturer.
 - b. Manufactured in 1979 or later as indicated and verified on a date stamp or code, located on the ballast.
 - c. Labeled as "Electronic Ballasts" by the manufacturer.
 - d. General Electric HDF Ballasts manufactured from 1977 to 1978 and which have a "W" added to their catalogue number on the label of the ballast.
31. Removal -- Procedures necessary to remove hazardous materials such as, but not limited to, asbestos or lead from designated areas and to dispose of these materials at an acceptable properly permitted waste disposal site.
32. Surfactant -- A chemical wetting agent added to water to improve penetration.
33. Universal Waste -- Certain common designated hazardous wastes that are required to be handled and disposed of or recycled in accordance with special rules. Includes fluorescent light tubes, HID lamps, sodium vapor lamps, mercury switches, mercury thermostats, NiCad, Silver, & Mercury & other batteries (often used in building alarms and emergency systems), and other items.

34. Visually Clean -- Free of visible dust, paint chips, dirt, debris, or films removable by vacuuming or wet cleaning methods specified. For outside soil or ground cover areas, visually clean shall mean free of construction or paint debris, chips or dust distinguishable from the initial soil or ground conditions.
35. Waste Generator Label -- Waste Generator label shall include the Generator's Name, ID Number, Address, and Waste Manifest Number.
36. Wet Cleaning -- The process of eliminating asbestos or lead contamination from building surfaces and objects by using cloths, mops, or other cleaning tools that have been dampened with water or water/detergent solution, and by afterwards disposing of these cleaning tools and materials as contaminated waste.
37. Work Area -- Designated rooms, spaces, or areas of the project in which hazardous material removal actions are to be undertaken or which may become contaminated as a result of such removal actions during the process and prior to final clean-up and decontamination. A contained Work Area is a Work Area that has been sealed and equipped with a Decontamination Enclosure System. Also referred to as a "Regulated Area."
38. Worker Decontamination Enclosure System (Worker Decon) -- That portion of a Decontamination Enclosure System designed for controlled passage of workers, and other personnel and authorized visitors, typically consisting of a clean room, a shower room, and an equipment room.

1.5 CONTRACTOR SUBMITTALS

- A. Requirements are as set forth in the Section 01300 – Submittals, for items required to be submitted under this section. Submit the following:
 1. Licensing and Registration for Contractor or Subcontractor responsible for removal of hazardous materials. Submit copies of current and valid:
 - a. The Contractor's license and Contractor's asbestos certificate issued by the California State Contractor's Licensing Board (CSLB);
 - b. Registration for Asbestos-Related Work from the Division of Occupational Safety and Health in accordance with CCR, Title 8, Article 2.5 of the California Administrative Code;
 2. Personnel Qualifications: Personnel documents required per this section shall be organized by individual employee and include the following information:
 - a. Personnel Training (asbestos)
 - 1) Competent Person/Supervisor: Submit a copy of current AHERA asbestos training certificates for the Contractor's Competent Person and Quality Control Person documenting successful completion of a training course in asbestos abatement project supervision offered by a Cal/OSHA accredited educational institution. Designate by name the person who will act as the Certified Supervisor/Competent Person and Qualified Person will be for the project.

- 2) Workers: Submit a copy of the current asbestos training certificates for the Contractor's asbestos abatement workers documenting successful completion of a training course in asbestos abatement for workers offered by an EPA accredited education institution.
 - b. Medical Examination: Submit proof that personnel who will be performing asbestos-related work have had medical examinations within the last 12 months in conformance with Title 8 CCR; Section 1529 asbestos, and furnish the results of each exam in the form of the physician's written opinion or approval with regard to worker fitness to wear a respirator and perform asbestos work as applicable.
 - c. Respirator fit tests: Submit proof that personnel who will be entering asbestos Work Areas have had a qualitative respiratory fit test performed within 12 months from the scheduled completion date of the project.
3. Notifications, Communications, and Postings.
 - a. Submit copies of notifications to appropriate government agencies where required, including the following:

Division of Occupational Safety and Health
455 Golden Gate Ave. Room 1524
San Francisco, California 94102
(415) 703 – 5210
Notifications shall be in accordance with the Title 8 CCR Section 341.9 for asbestos and Section 1532.1 for lead.

Bay Area Air Quality Management District (AQMD)
939 Ellis Street
San Francisco, CA 94109
(415) 771 – 6000
Contact the agency for the requirements of notification
 - b. Copies of Government agency correspondence shall be included in the submittals.
4. Respiratory Protection Plan: Submit a written standard operating procedure governing selection, fit-testing, and use of respirators for asbestos and lead removal.
5. Detailed Work Plan: Submit a detailed work plan proposed for use in complying with the requirements of these specifications. The detailed work plan shall include, at a minimum, the following information:
 - a. Procedures: Job-specific procedures proposed for completing the scope of work outlined herein including: means of Work Area containment including barriers and other protective measures for removal at each location; means for provision of decontamination units; removal methods to be employed;
 - b. Detailed schedule with calendar dates showing all phases of work. Where scheduled start dates have not been confirmed, provide the number of consecutive work days to complete each phase of work.

6. Plan for personnel air monitoring required by law by the Contractor for Worker protection. The Plan shall include, but not be limited to the following:
 - a. Personnel Air Monitoring conducted in strict accordance with 8 CCR 1529. Include calibration data for the secondary standard to be used for air sampling pump calibration on-site. This data must be within six (6) months of the projected completion of this project.
 - b. Name, address and accreditation and/or certification of laboratory selected by the contractor to analyze air samples.
 7. Product Data: Manufacturers product data for all items required for complete and proper execution of the work, this includes product data for all items listed under Part 2 - Products. Product data shall include manufacturing product data, specifications, samples and application instructions, material safety data sheet (MSDS), and other pertinent information as necessary.
 8. Waste Disposal Sites: Submit Name Location, Class, and EPA # for each waste disposal site to be used for asbestos, lead, PCB, and other hazardous wastes for this project.
- B. Daily Submittals: Within 24 hours following the completion of each Work Shift, the Contractor shall submit the following information to the Observation Service.
1. A complete asbestos worker employee roster for each work shift prior to the commencement of each shift.
 2. Work Area entry/exit logs completed for each Work Area and each Work Shift.
 3. OSHA sample results for asbestos including Eight (8) hour Time Weighted Average (TWA) sampling and results for asbestos excursion limit samples. Sample results must indicate the person sampled, description of work activity, start and stop times, liters per minute, total volume and laboratory result expressed as an eight-hour TWA or excursion limit sample.
 4. Waste Manifests:
 - a. Each time hazardous waste (lead, PCB, etc) is picked up from the site the Contractor is responsible for submitting the generator (yellow) and DOSH (blue) copies to the Owner's Representative.
 - b. Each time a non-hazardous asbestos waste is shipped, the Contractor shall provide a copy of the non-hazardous shipping manifests to the Owner's Representative.
 - c. All asbestos and other hazardous material waste manifests are to be reviewed and signed by an Owner Representative.
 - d. All materials shipped for recycling (lighting tubes, mercury, etc.) shall be accompanied by a manifest and a copy of the manifest shall be provided to the Owner Representative.
 - e. Land Disposal Restrictions: Submit a copy of the completed Notice and Certification with each Hazardous Waste Manifest for wastes intended for land disposal pursuant to Section 67740 of 22 CCR) signed by the cogenerator to the Owner's Representative.

C. Close-Out Submittals:

1. Within 10 days of completion of all hazardous material removal work, submit a copy of all outstanding daily submittals and one copy of each hazardous waste manifest and each non-hazardous asbestos waste manifest to the Observation Service.
2. Work Area entry/exit logs completed for each Work Area and each Work Shift.

1.6 CERTIFICATIONS

A. Inspection Certifications (Asbestos)

1. Pre-Abatement Visual Inspection Forms and Final Visual Inspection and Clearance Certification Forms will be provided at the pre-construction start up meeting by Observation Service.
2. Pre-Abatement Visual Inspection: Upon inspection and approval of each Work Area by the Contractor's Certified Supervisor, a Pre-Visual Inspection Form shall be signed and submitted to the Observation Service for review and approval. The approved inspection form shall be considered notice to proceed with abatement operations within the Work Area.
3. Final Visual Inspection and Clearance Certification. Upon completion of asbestos abatement and before encapsulation in each Work Area, the Contractor's Certified Supervisor shall thoroughly inspect the Work Area for completeness of work. The Contractor's Competent Person shall sign and submit a completed Final Visual Inspection and Clearance Certification Form for review and approval by the Observation Service. The approved inspection form shall be considered notice to proceed with encapsulation.

1.7 POSTINGS

- A. Before the commencement of any asbestos related work at the site, Cal/OSHA warning signs in and around the Work Area to comply with Cal/OSHA regulations.
- B. Copies of the Contractor's SCLB license, Cal/OSHA registration certificate, temporary job-site notifications, pre-start LBP notifications to Cal/OSHA, local agency notifications, emergency exit diagram, emergency phone numbers, Cal/OSHA poster on worker's rights, and worker's compensation poster shall be posted proximate to the entrance to each Work Area.
- C. The Contractor shall have at least one copy of the Contract Documents including project plans and specifications, and a current copy of 8 CCR 1529 & 1532.1.

PART 2 PRODUCTS

2.1 GENERAL: SUBMIT MANUFACTURER'S PRODUCT DATA FOR ALL ITEMS TO BE USED INCLUDING THE ITEMS LISTED BELOW.

- A. All materials to be used on the project shall be new in original packages, containers, or bundles bearing the name of the manufacturer and the brand name. Used materials will not be permitted.

2.2 PROTECTIVE COVERING (PLASTIC SHEETING)

- A. For standard containment and critical barrier usage: Fire Retardant Polyethylene sheets 6 mil and 4 mil in sizes to minimize frequency of joints, approved and listed by the State Fire Marshall per Section 13121 and/or 13144.1 of the California Health and Safety Code.

2.3 TAPE, ADHESIVE, SEALANTS

- A. Duct tape two inches or wider, or equivalent, capable of sealing joints of adjacent sheets of plastic sheets and for attachment of plastic sheets to finished or unfinished surfaces of dissimilar materials and capable of adhering under both dry and wet conditions.
- B. Spray adhesives for sealing polyethylene to polyethylene shall contain no methylene chloride compounds.

2.4 PROTECTIVE PACKAGING

- A. Appropriately labeled 6 mil sealable polyethylene bags as a minimum.
- B. Appropriately labeled, impermeable drum containers with sealable lids
- C. Bilingual labels (English and Spanish) on waste packages, contaminated material packages and other containers shall be in accordance with EPA or OSHA standards.

2.5 WARNING LABELS AND SIGNS

- A. All warning signs and labels must meet all applicable regulatory requirements for wording, size of lettering, and use of language, pictographs, and graphics to effectively convey the warning. Additional requirements apply for hazardous waste containers and shipments for transportation to disposal sites.
- B. Lead Caution Signs must include phrase "Caution Lead Hazard, Keep Out Unless Authorized" in minimum two-inch high letters. These shall be posted at each approach to each lead paint stabilization/surface preparation and manual demolition Work Area.
- C. Cal/OSHA Lead Warning Posters: "**Warning - Lead Work Area, Poison, No Smoking or Eating**" shall be posted at the entrance to each LBP stabilization/surface preparation and manual demolition Work Area.
- D. Asbestos Warning signs for Regulated Areas must contain the following wording:

DANGER

**ASBESTOS
CANCER AND LUNG
DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE
CLOTHING ARE REQUIRED IN THIS AREA**

- E. Labels for packaging and containers containing ACM waste must contain the following wording:

**DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD**

2.6 SURFACTANT

- A. Surfactant, or wetting agent, for amending water will be 50 percent polyethylene ether and 50 percent polyethylene ester, or equivalent, at a concentration of one ounce per five gallons of water.

2.7 PERSONAL PROTECTIVE EQUIPMENT

- A. Personal Protective Equipment shall comply with the requirements of 29 CFR 1910, Subpart 1 and 8CCR 1514, 1515, 1516, and 1517.
- B. Work clothes shall consist of impervious disposable, full-body coveralls, head covers, boots, rubber gloves, and work boots (or sneakers). Sleeves at wrists and cuffs at ankles shall be secure.
- C. Eye protection and hard hats shall be available and worn when required by applicable safety regulations.
- D. Provide Authorized Visitors with suitable protection clothing, headgear, eye protection, and footwear whenever they enter the Work Area.

2.8 RESPIRATORS

- A. Provide all workers, foremen, superintendents, authorized visitors, and inspectors personally-issued and marked, clean and sanitized respiratory equipment approved by NIOSH. When respirators with disposable filters are employed, provide sufficient filters for replacement as recommended by manufacturers or this specification. Selection of respirators shall be made according to the guidance of 8 CCR 1529 and 1532.1.
- B. The minimum respiratory protection required for this project is a half mask respirator as long as the airborne levels do not exceed one tenth of the applicable PEL established by regulation.

PART 3 EXECUTION

3.1 PROJECT PROCEDURES

- A. Prior to the start of on-site work, the Contractor shall hold an on-site start-up safety meeting for all of contractor and facility employees that addresses at least the following issues specific for the project.
 - 1. Safety and health hazards;
 - 2. Procedures and work practices;
 - 3. Respiratory protection and instruction;
 - 4. Special conditions and/or work requirements.
- B. Worker Protection Procedures
 - 1. Provide Authorized Visitors with suitable protective clothing, respirators, headgear, eye protection, and footwear whenever they are required to enter the Work Area. All provided equipment shall be new or in good working condition and clean, sanitized, and inspected by a competent person since last use.
 - 2. Each Worker and Authorized Visitor shall, upon entering the job site: remove street clothes in the clean-change rooms and put on a respirator and clean protective clothing before entering the Work Area.
 - 3. Workers shall, each time they leave the Work Area, remove gross contamination from protective clothing before leaving the Work Area, proceed to the Equipment Room or decontamination area and remove protective clothing except respirators; still wearing the respirator, proceed to the showers or wash area, clean the outside of the respirator with soap and water while showering; remove the respirator, and thoroughly shampoo and wash themselves.
 - 4. Following washing and/or showering and drying off, each Worker shall proceed directly to the clean change room/area and dress in clean clothes at the end of each day's work, or before eating, smoking, or drinking. Before re-entering the Work Area from the clean change room, each Worker and Authorized Visitor shall put on a clean respirator and shall dress in clean protective clothing.
 - 5. Contaminated work footwear shall be stored in the Decontamination Area when not in use in the Work Area. Upon completion of abatement, dispose of footwear as contaminated waste.
 - 6. Workers removing waste containers from the Equipment Decontamination Enclosure shall enter the Holding Area from outside wearing a respirator and dressed in clean disposable coveralls. No Worker shall use this system as a means to leave or enter the Wash Room or the Work Area.
 - 7. Workers shall not eat, drink, smoke, or chew gum or tobacco while in the Work Area.

8. Workers and Authorized Visitors with beards shall not enter the Work Area unless equipped with respirators approved for use with beards.

3.2 COORDINATION REQUIREMENTS

- A. Coordinate with the Observation Service and Owner's Representative the locations of the Worker Decontamination Unit, waste load out, staging areas, and emergency egress exits.
- B. Coordinate timing of waste bag-out activities with the Owner's Representative and Observation Service. The Contractor shall be aware that these activities may need to take place during times when it is most convenient to the facility.
- C. Coordinate and provide to the Observation Service the required number of power outlets needed inside and outside each Work Area. These outlets shall be solely dedicated for the use of the Observation Service.

3.3 PREPARATION

- A. General Requirements (Lead and Asbestos)
 1. Provide temporary power and lighting and ensure safe installation of temporary power source and equipment per applicable electrical code requirements and provide ground fault interrupter circuits with power source for electrical equipment to be used.
 2. Provide temporary supply of water adequate for wet removal, cleaning, decontamination and operation of employee shower system (where required).
 3. Isolate any heating, cooling, ventilation air systems that enter or penetrate the building within or near the Work Area to prevent contamination of other areas of the structure.
 4. Install a Decontamination Enclosure System or equivalent prefabricated portable decontamination unit(s) as approved for asbestos work areas. Establish a dedicated decontamination area for lead related exterior work. This system will be the primary entrance and exit to the Work Area.
 5. Seal off all other accesses to interior Work Area with plastic sheeting sealed with tape ensuring provisions for emergency egress.
 6. For exterior work areas, pre-clean grounds and horizontal surfaces surrounding building/structures to remove all visible paint chips, trash and debris within Work Areas and at least five feet beyond.
 7. Establish exterior lead removal regulated areas and exterior asbestos roofing, gasket, and caulking removal regulated areas using barrier tape and signage at minimum. Each area shall have a designated decontamination area for exiting the work area and a designated clean area for entry.
 8. Place exterior plastic drop cloths within boundary of the Regulated Area and below exterior asbestos caulking and deteriorated LBP removal areas and out at

least five feet beyond the extent of removal or 10 feet from the building foundation, whichever is more.

9. Seal all remaining openings to interior Work Areas, including but not limited to ducts, grills, diffusers, and any other penetrations of the Work Area, with two layers of plastic sheeting sealed with tape.
10. Isolate non-emergency egress doorways, and access ways with temporary barriers and seal with plastic sheeting. .
11. Establish and maintain emergency and fire exits from the Work Areas.

B. Decontamination Enclosure System (General)

1. Construct or establish Decontamination Enclosure System or area contiguous to the work area for proper decontamination of worker as they exit a Regulated Area or containment system.
2. Provide separate designated areas or chambers for: removal of contaminated clothing prior to exiting the contaminated area; for washing or showering (as appropriate); and for donning clean protective clothing and equipment prior to reentry. The decontamination system shall comply with applicable regulation taking into account the Cal/OSHA asbestos removal work class as well as site conditions.
3. In the event that the Decontamination Enclosure System is not contiguous with the Work Area, there must be at least an established area for removing and properly disposing of contaminated clothing and equipment, minimum amenities for washing hands, respirator and face, to allow exiting the work areas prior to going to a remote decontamination enclosure on site. Under these conditions, double suit procedures are required.

C. Maintenance of Enclosure Systems

1. Ensure that all barriers intact and are effectively sealed and taped. Repair damaged barriers and remedy defects immediately upon discovery.
2. Visually inspect enclosures at the beginning of each work period and periodically throughout each shift. Inspection shall include, but not be limited to, the protective critical barriers and the worker Decon unit barriers, warning signage, and Work Area barriers or barricades.
3. Use smoke test methods to evaluate effectiveness of barriers prior to implementing asbestos removal and when directed by the Observation Service.

D. Asbestos removal work shall not commence until:

1. Submittals as required herein have been reviewed and approved in writing by the Observation Service.
2. Arrangements have been made for secure temporary storage of asbestos wastes on-site and for disposal of such wastes at an acceptable permitted disposal sites.

3. Work Areas and Decontamination Enclosure Systems (or equivalent) and parts of the building or facility required to remain in use are effectively segregated and isolated.
4. Tools, equipment, and material waste receptors are on hand.
5. Arrangements have been made for security during removal operations.
6. Differential pressure systems, as required for interior asbestos removal, are installed, operating, and recording properly.

3.4 CLASS II ASBESTOS REMOVAL OPERATIONS

A. General: Class II Asbestos Work is defined as the removal of ACM that is not a surfacing material or thermal system insulation. For this project, Class II includes, but is not limited to removal of the following materials: resilient floor tiles and mastics, roofing sealants and patching compounds, caulking materials, gaskets, tar and paper wrapping of piping, and other non-friable ACM materials.

B. General Removal Procedures:

1. Spray asbestos materials with amended water, using only spray equipment capable of dispensing a fine mist application. Apply amended water sufficiently to wet material surfaces without causing excess dripping or pooling. Spray materials and Work Area repeatedly during work process to control airborne fiber levels.
2. Remove dampened asbestos caulking, patching and sealant materials using cutting tools, scrapers, and other tools in small manageable sections or pieces. As it is removed, immediately place materials in six (6) mil sealable plastic bags or appropriate containers labeled with required OSHA asbestos warning information.
3. Place asbestos waste in clear asbestos-labeled plastic bags or lined drums. Plastic bags must be sealed using the "goose neck" technique by twisting the neck of the bag, bending it over and taping it with multiple wraps of tape. Clean external surfaces of containers thoroughly prior to setting down on a clean plastic drop cloth.
4. Move waste containers to washroom or wash area, wet clean each container thoroughly, and move to holding area pending removal to uncontaminated areas.
5. After completion of removal work, equipment surfaces from which asbestos has been removed shall be wet cleaned and/or wet sponged by an equivalent method to remove all visible material and residue. During this work, the surfaces being cleaned shall be kept damp. Do not allow water to pond at any time.
6. Clean all surfaces of the Work Area including remaining sheeting by use of damp cleaning and/or HEPA filtered vacuum.
7. Proceed with final decontamination of the Work Area.

C. Glove bag Technique (Class II/Non-friable material):

1. Removal of non-friable coatings or other Class II asbestos-containing materials from piping may be accomplished using approved glove bag techniques in specified areas.
2. Modified decontamination systems used in combination with an on-site remote shower may be acceptable for glove bag removal if conducted in accordance with an approved written work plan submittal.
3. Thoroughly wet material to be removed with amended water before and during the removal process.
4. Thoroughly wash the inside of the bag, the piping surfaces and the tools upon completion;
5. Encapsulate all surfaces inside the glove bag including the piping and ends of exposed coating material.
6. Evacuate bag with an approved HEPA vacuum; tie off waste area; remove tools from bag; remove bag from pipe, folding inward the sides of the bag; then twist and tape the open end, the wand opening, and the vacuum opening.
7. Place glove bag directly into another six mil sealable labeled plastic waste bag or other appropriate waste container. Seal the outer bag using the "goose neck" technique by twisting the neck of the bag, bending it over and taping it with multiple wraps of tape. Seal container with duct tape.

D. Cut, Wrap, and Remove Technique

1. Removal of non-friable ACM coating from piping may be accomplished using approved Cut, Wrap, and Removal Techniques where piping is to be demolished or abandoned in place unless otherwise noted.
2. Verify the piping being removed scheduled for removal or abandonment in place prior to proceeding.
3. Verify pipe lines have be isolated and drained prior to cutting pipe(s).
4. Install glove bags at sections where the pipe will be cut and seal to polyethylene sheeting.
5. Remove ACM coating using the glove bag method at locations where pipe is to be cut.
6. Wrap pipe being removed with two layers of six mil polyethylene sheeting secured with duct tape.
7. Cut the pipe and remove for disposal.

E. Removal of ACM Gasket Materials

1. Establish a regulated area consisting of barriers/barrier tape and warning signs at least 10 feet from the point of removal.

2. Pre-clean immediate foundation or deck areas surrounding the pipe flange and install plastic sheeting drop sheet.
3. Establish Decontamination Area at the point of entry/exit to the regulated Work Area. After entering/exiting the regulated Work Area, the Contractor may use a remote decontamination/shower system.
4. Unbolt or disassemble the pipe flange at the gasket area, then wet and separate the pipe at the flange.
5. Remove the asbestos gasket to the greatest extent possible by wet cutting and scraping to remove the gasket in whole pieces if possible. Carefully scrape any residue off the flange and pipe surfaces.
6. Place removed waste promptly in asbestos waste bags and remove from the site at the end of the work day.
7. Acceptable clearance criteria for gasket removal shall be no visible three-dimension residue at removal locations.
8. All non-friable gasket waste shall be disposed of as a non-hazardous asbestos waste at a landfill permitted for asbestos wastes. All asbestos contaminated materials shall be shipped as asbestos wastes on a non-hazardous waste manifest.

3.5 FINAL ASBESTOS DECOTAMINATION AND CLEARANCE TESTING

- A. Previous Work: During completion of the interior asbestos removal and visible debris cleanup work specified, the first cleaning of all exposed equipment and building surfaces should be completed.
- B. Clean any remaining materials and debris exposed by the barrier removal. Final independent layer of polyethylene sheeting and all isolation barriers, vents, grilles, diffusers, etc., shall remain in place.
- C. At the completion of this cleaning phase, the Work Area shall be free of all unnecessary equipment/materials and waste containers.
- D. The Contractor's Competent Person/Supervisor shall perform a complete visual inspection of the Work Area under adequate lighting to ensure that the Work Area is free of visible asbestos material, debris, and dust.
- E. The Contractor's Competent Person/Supervisor shall ensure that additional cleaning is completed if the area is not acceptably clean. The Contractor shall submit a completed and signed Final Visual Certification Form along with a request for a final visual inspection by the Observation Service once the Competent Person/Supervisor concludes that the area is acceptable for final visual inspection.
- F. After written notification to proceed from the Observation Service, encapsulate all surfaces within the Work Area.

- G. After written notification from the Observation Service in the form of a fully completed Final Visual Inspection/Clearance Certification Form accepting decontamination of the Work Area as acceptable, proceed with removal of critical barriers.
- H. For exterior non-friable ACM removals such as roofing materials, sealants, caulking, gaskets, Transite pipe and/or similar materials, final clearance will be by visual inspection by the Observation Service. If all ACM materials have been removed and the Work Area is free of visible ACM material, dust and debris, the removal will be considered complete.

3.6 LEAD WASTE CLEAN UP AND WASTE EVALUATION

- A. Clean up paint chips and debris using wet cleaning methods and HEPA vacuuming. All surfaces shall be free of all visible paint chips, dust and debris. Place all paint chips in a labeled waste bag or container.
- B. Place all contaminated cleaning materials, disposal personal protective equipment (PPE) and contaminated plastic in separate waste bags. The Contactor shall assume all lead-related waste is RCRA hazardous waste and shall conduct required waste testing as necessary for disposal at a permitted waste disposal site.
- C. All waste streams and waste categories listed below shall be considered lead hazardous waste until proven otherwise through testing. All testing of demolition waste wastes is the responsibility of the Contractor. The Contractor shall be responsible for segregating suspect lead hazardous waste based on potential for exhibiting hazardous waste characteristics. Lead-related wastes are to be segregated into the below listed categories at a minimum.
 - 1. Category I: LBP paint chips, vacuum bags, used cleaning materials. These materials are typically hazardous wastes.
 - 2. Category II: Plastic sheeting and tape, disposable clothing, and equipment. These materials should be non-hazardous if properly cleaned and decontaminated. However, these items are to be considered hazardous subject to testing.
- D. Based on the testing protocols, any waste greater than or equal to five (5) ppm lead using STLC or TCLP tests or any waste greater than or equal to 1000 ppm lead using the TTLC test shall be considered a California hazardous waste.
- E. When the TTLC test result is less than 50 ppm lead, no further testing is required for that waste category sampled unless the waste stream or waste generating process changes.

3.7 LEAD-RELATED DEMOLITION

- A. General. All painted or coated surfaces are known or presumed to contain lead subject to worker protection and environmental regulations. Refer to related documents identified herein for additional information including components with LBP requiring agency notification.
- B. Conduct selective as well as general building and structural demolition in a manner that does not result in site contamination above background levels.

1. Remove any loose, peeling, or flaking paint before demolition in accordance with this section;
 2. Clean up any demolition-related lead wastes including any resulting paint chips and debris.
- C. The Contractor shall evaluate each demolition debris waste stream and ensure proper disposal of all generated wastes. All waste profiling and testing required by the disposal site is the responsibility of the Contractor.

3.8 FLUORESCENT LIGHTING FIXTURES

- A. Remove fluorescent lighting tubes from fixtures in and on buildings to be demolished.
1. Carefully place all tubes in storage or shipping containers so the risk of breakage is minimized.
 2. Place containerized light tubes in a safe and secure storage area pending shipping to the recycler.
- B. Remove presumed PCB ballasts from all fluorescent lighting fixtures in buildings to be demolished.
1. Any ballast not marked "PCB Free" or "No PCB" shall be lab packed with adsorbent in a waste drum for disposal as hazardous PCB ballast waste.
 2. Ballasts that are clearly marked "PCB Free" shall be set aside for verification inspection by the Observation Service. All ballasts verified to be PCB free may be disposed of as ordinary construction waste or recycled.
 3. Ensure PCB ballast drum is properly labeled for PCB wastes and shipping.

3.9 OTHER UNIVERSAL WASTES

- A. Carefully remove mercury-containing thermostats, batteries for emergency lighting, and other universal wastes for disposal as hazardous wastes.
- B. Carefully segregate waste by type and lab pack for disposal in impervious labeled waste containers.
- C. Dispose of or recycle each type of waste in accordance with applicable regulation at permitted facilities. Maintain all shipping and disposal record and provide copies to Owner's Representative and the Observation Service.

3.10 PACKAGING AND LABELING

- A. All asbestos wastes shall be adequately wetted prior to packaging.
- B. Place asbestos waste in six (6) mil labeled asbestos waste bags or approved equivalent containers.
- C. Goose neck and seal each bag and place in a second clean-labeled bag, drum or impervious container.

- D. Decontaminate waste bags and containers prior to removing from regulated or contained area.
- E. Label all asbestos waste bags or containers with OSHA warning label: "Danger. Contains Asbestos Fibers. Avoid Creating Dust. Cancer and Lung Disease Hazard" and other information as required by regulation.
- F. All other hazardous lead, PCB, and universal wastes shall be properly labeled and containerized in leak tight containers.

3.11 WASTE DISPOSAL

- A. Waste Transportation: Submit the method of transport of hazardous asbestos wastes including name, address, EPA ID number, and telephone number of transporter.
- B. Waste Disposal Site(s): Submit for approval the name, class, address, EPA ID number, and telephone number of waste disposal site(s) to be utilized for:
 - 1. Disposal of non-hazardous non-friable asbestos wastes;
 - 2. Disposal of hazardous lead, PCB, and Mercury wastes; and
 - 3. Disposal of any other universal wastes
 - 4. Disposal of waste solvents, paints, lubricants and oils
- C. Waste Manifest: Submit for approval at the Pre-construction meeting a filled out Waste Manifest form. For Waste Manifest purposes, the Generator is the facility of the subject work.
 - 1. Obtain necessary information including generator EPA number for this purpose from the Owner or Owner's Representative prior to start up of any abatement or demolition.
 - 2. After removal and packaging waste for shipment, provide a copy of the Waste Manifest to the Observation Service for each required shipment.
 - 3. Use the uniform hazardous waste manifest for hazardous wastes including lead, PCBs and mercury. Include a properly completed Land Disposal Restriction Notice and Certification form with each manifest submitted for signature by the generator.
 - 4. Use a non-hazardous wastes manifest for disposal of non-friable asbestos wastes.
- D. Each hazardous waste manifest and each non-hazardous asbestos waste manifest shall be prepared for the Owner or Owner's Representative's review and approval prior to shipment.
- E. The sealed hazardous waste containers shall be delivered to the Contractor's predesignated, approved hazardous waste treatment and waste disposal site for burial in accordance with applicable state and federal regulations. Likewise, non-hazardous

asbestos waste shall be delivered under manifest to a permitted asbestos waste disposal site.

- F. Notify the Owner's facility representative 48 hours in advance of the time when contaminated materials are to be removed and transported from the site to allow for manifest review and approval.
- G. The Contractor shall be responsible for safe handling and transportation of all hazardous waste generated by this Contract to the designated Hazardous Waste Site and shall hold the Owner and the Owner's agents and consultants harmless for claims, damages, losses, and expenses against the Owner, including attorney's fees arising out of our resulting from asbestos and hazardous materials spills on the site or en route to the disposal site.

3.12 AIR MONITORING

A. Area Air Monitoring

- 1. Throughout the asbestos removal process, area air monitoring may be conducted by the Observation Service to ensure work is done in conformance with the fiber concentration limits of these specifications. Likewise, lead removal work areas may be visually inspected or monitored during removal.
- 2. If results of area air monitoring outside the Work Area are in excess of 0.01 f/cc for asbestos work areas or 1.5 micrograms of airborne lead per cubic meter of air for lead, the Contractor shall make changes in work procedures to assure compliance with minimum standards. At a minimum, the Contractor shall stop all work and implement additional remedial controls and conduct decontamination as necessary in response to exceeding these limits.
- 3. Unsatisfactory asbestos results are fiber counts in excess of 0.01 fibers/cc by PCM Method NIOSH 7400 determined as a TWA outside the Work Area by general air monitoring. All results greater than 0.01 fibers/cc shall be subject to further laboratory analysis by the TEM method at the Contractor's sole expense.

3.13 CLOSE-OUT

- A. All submittal and punch list items must be complete and provided to the Observation Service. These include daily work force rosters, work area sign-in/ out sheets, and waste test data and waste manifests.

3.14 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are part of this Specification.
 - 1. Hazardous Material Pre-Demolition Inspection and Bulk Sampling Various Structures at the Sausalito-Marín City Treatment Plant, December 17, 2014

END OF SECTION

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SECTION 02100 - SITE PREPARATION & PLANT PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for clearing and grubbing, demolition, removal, salvage, relocation reconstruction, or other disposal and/or reconstruction of existing facilities which interfere with the construction, including removal of items below ground.
- B. Preserve and protect all improvements to remain, including existing trees, shrubs, utilities, pavements, structures and improvements on adjoining properties during removal work, site preparation work and construction.
- C. Layout and review of utility and irrigation trenches that occur in the Tree Protection Root Zone is required as part of this Site Prep and Plant Protection work as described below in PART 3 EXECUTION.
- D. Related requirements specified elsewhere include:
 - 1. Section 02200 EARTHWORK
 - 2. Section 02810 IRRIGATION
 - 3. Section 02900 PLANTING

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard than is required by the above mentioned codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
 - 2. International Society of Arboriculture, Guide for Plant Appraisal, latest version.

1.3 DEFINITIONS

- A. Diameter at Breast Height of tree trunk (DBH)
 - 1. Location 54 inches from the ground as measured on the high side of the tree trunk.
- B. Tree Protection Zone (TPZ)
 - 1. Root Area around tree that is 5 times the DBH, or the tree Dripline, whichever is greater.
- C. Structural Root Zone (Radius of Three)
 - 1. The Structural Root Zone is a circular area with the tree trunk at the center and a radius equal to 3 times the diameter of the tree trunk measured at breast height (4.5 feet above ground line). This zone, where most of the structural roots exist,

is based upon tree failure research conducted by E.T. Smiley at the Bartlett Tree Research Laboratory. Any structural (buttress) root, which has been severed or is rotten within this zone, can no longer provide adequate support to the tree and must be considered missing.

D. Dripline

1. The area of the ground directly beneath the vertical projection (shadow) of the trees foliage canopy.

1.4 QUALITY ASSURANCE

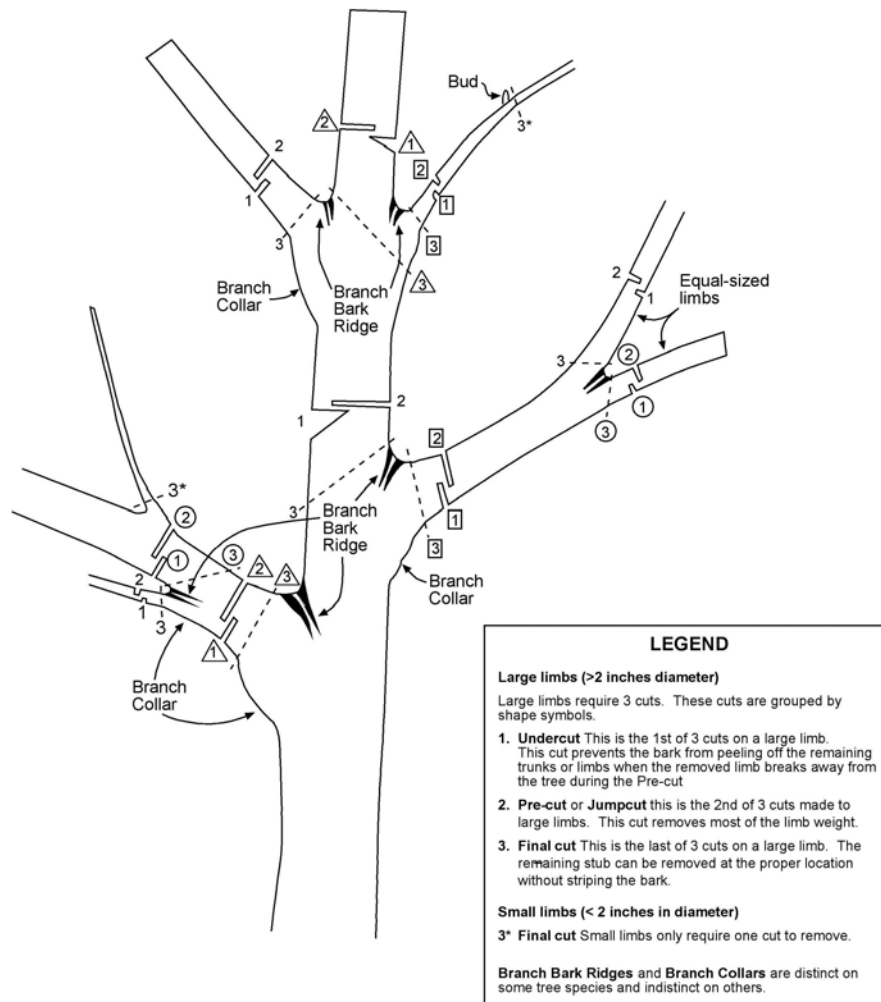
A. Review:

1. Contractor shall review and identify with the Owner's Representative the limits of Work and extent of plant materials and other improvements to be protected. Notify Owner's Representative of discrepancies between existing conditions and Drawings before proceeding with Work.
2. At the Owner's discretion, an Arborist may represent the Owner to review the work of the Contractor in regards to plant protection.
3. Pre-demolition Conference: Conduct conference at Project Site to review methods and procedures related to selective demolition including, but not limited to, the following:
 - a. Inspect and discuss condition of construction to be selectively demolished.
 - b. Review structural load limitations of existing structures.
 - c. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - d. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - e. Review locations within Tree Protection Zones where trenching may interfere with existing root systems and propose alternate trench locations to avoid or reduce damage to root systems. Refer to PART 3 - EXECUTION.
 - f. Review areas where existing construction is to remain and requires protection.
4. Pre-demolition: Prior to beginning Work, photographically record existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations and furnish copies to the Owner's Representative prior to beginning work.

B. Stipulations

1. Plant Protection:
 - a. Protect trees and shrubs against cutting, breaking, skinning and bruising of bark; permit no traffic or stockpiling within drip line.
 - b. Do not change earth surface within drip line of trees and shrubs except as approved in writing by the Owner.
 - c. Do not park vehicles or store materials, supplies and construction equipment within Tree Protection Zone.
 - d. Install a temporary 4-foot high orange plastic construction fence as manufactured by White Cap or approved equal, typically at the "drip line" of the tree(s) and planted areas to be protected from construction damage, except as otherwise directed by the Arborist / Owner's Representative. Post may be steel driven type, or self-supporting type.

- e. Obtain specific instruction from Arborist / Owner's Representative for pruning of trees, shrubs, roots or disturbance of soil within spread of tree branches. The Contractor shall utilize protection measures as outlined by Arborist / Owner's Representative, which may include directional drilling, or hand clearing to expose the roots.
- f. Generally cutting of roots two inches or greater shall be avoided. Roots one inch and greater in diameter that must be cut shall be cut cleanly and obliquely with the cut surface facing down.
- g. Exposed and pruned roots shall be covered with light well-drained soil backfill and mulch over. The area shall be kept moist.
- h. Unless the Contractor has secured and marked approved trench locations within Tree Protection Zones prior to beginning trenching, any trenching required within the Tree Protection Zone, shall be done by hand and as directed by the Arborist / Owner's Representative.
- i. Provide periodic watering for all planting within Contract limit and any adjacent areas affected by the work. Maintain moisture to a minimum 6" depth as accepted by the Owner's Representative.
- j. Using an approved pruning saw, provide selective tree limb pruning as accepted by the Owner's Representative if branches interfere with new



construction. Limb diameter shall be limited to 5" diameter and shall be pruned just outside the branch collar in accordance with American National

Standards Institute, (ANSI 300) and International Society of Arboriculture, (ISA) standards.

- k. Approved branches to be shortened must be cut just above a fork with another living branch which is plus or minus 1/2 the diameter of the removed branch as shown in the pruning figure herein. Branches to be removed which exceed 2" in diameter shall be severed with a 3-step cut to prevent bark peeling. Final cuts must not injure the branch collar or branch bark ridge of the remaining branches and trunk.

C. Air Spading:

1. Air spading, or hand removal of soil or tunneling is required for excavation in the Tree Protection Zone of any trees for the installation of infrastructure where roots 2 inches in diameter and larger are encountered. The "critical root zone" is defined as any area around a tree in which a two inch diameter root is encountered. The Arborist / Owner's Representative shall define the critical root zone and the Contractor shall excavate using a pneumatic excavator (AIR-SPADE or equivalent) as follows:
2. Trenching for utility lines or other infrastructure may be done mechanically outside the Tree Protection Zone. As the equipment operator approaches the canopy radius, or for certain species up to 1.5 times the canopy radius out from the base of the tree (Oaks, Poplars, Redwoods, etc.) the operator shall be assisted by a spotter who shall inspect the excavation for roots. If a root of two inches diameter is encountered the spotter shall halt mechanical excavation and pneumatic excavation shall proceed. If no other two inch or greater diameter root is encountered in an excavation of two feet forward and two feet deep, the single two inch root may be cleanly cut proximal to (on the tree side of) any fracture or torn bark. Mechanical excavation may continue until a two inch diameter root is encountered, and the pneumatic excavation, exploration is then repeated.
3. The Contractor shall control dust and the spread of soils excavated. The air-spade operator shall moisten the soil to field capacity and to a minimum probe depth of 2.5 feet with a watering needle (hydro-spear) 48 hours prior to pneumatic excavation. The spread of excavated soil shall be contained to the area adjacent to the trench path with upright plywood sheeting.
4. These specifications shall not be considered operating instructions or a requirement to use a specific pneumatic excavation product. It is the responsibility of the Contractor to read and understand the pneumatic excavator operation instructions and safety procedures (including the proper and safe use of air compressor, hoses, excavation tools, etc.) prior to operations.

D. Plant Replacement: Contractor shall replace trees cut or severely damaged due to the Contractor's work as follows:

1. An ISA Certified Arborist may be retained by the Owner to determine the condition of trees in question as to their ability to survive in a healthy condition and in their original shape, or a pruned aesthetically pleasing shape acceptable to the Owner. Comply with recommendations to rehabilitate as recommended by the Arborist, or to replace in accordance with the requirements below.
2. Trees size shall be determined by Diameter at Breast Height (DBH). Replacement of trees and shrubs shall also include providing acceptable plant installation, automatic irrigation system and a minimum maintenance period of 120 days. If plant(s) is not acceptably maintained and is not healthy and thriving at the end of the 120 day maintenance period, the Contractor shall continue the maintenance work until such time that healthy tree(s) and/or shrub(s) is achieved.

3. Replace any damaged planting in kind using "specimen" plants as follows and at no cost to Owner:
 - a. Trees up to 3" DBH: Replace with 36" box size.
 - b. Trees 3" to 6" DBH: Replace with 72" box size.
 - c. Trees 6" to 12" DBH: Replace with 84" box size.
 - d. Trees 12" DBH and larger: Tree value shall be determined by Arborist using Council of Tree and Landscape Appraisers (CTLA) method. Replace damaged tree with largest available nursery boxed tree and cash difference between value of damaged tree and nursery stock replacement cost.
 - e. Shrubs: Replace with 15-gallon can size.

E. Work Included:

1. Coordinate shutoff of irrigation systems with the Owner and be responsible for any damage caused to adjacent landscaping by Contract work.
2. Site Preparation and Demolition
3. Work is in accordance with the Drawings and specifications and includes but is not necessarily limited to the following:
 - 1) Clearing and grubbing.
 - 2) Identification and protection of vegetation indicated to remain.
 - 3) Removal of existing site improvements, such as paving, curbs, gutters, fences, structures, slabs, foundations and walls.
4. Locate and identify existing utility services and provide coordination, shutoff, capping, and continuation of utility services.
5. Remove, store and protect all items designated and directed to be returned to Owner or reinstalled.
6. Obtain and pay for permits required for execution of this work.

- F. Hazardous materials: If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Owner.

1.5 SUBMITTALS

- A. Record Drawings: Indicate points of disconnection and capping, abandonment and removal of existing utility services; include utility names, sizes and locations, relationship to permanent structures located on site and on adjacent property, and certificates of severance of utility services from respective utility companies or owners.
- B. Survey of Existing Conditions: Provide to Owner a Survey of Existing Conditions. Record existing conditions, including underground utilities, etc. on As Built Drawings by use of field measurements and preconstruction photographs. Make permanent record of measurements, materials, and construction details required to make exact reproduction.
- C. Submittals to be as specified in Sections 01300 and 02500.

1.6 PROJECT CONDITIONS

- A. Coordination: Coordinate this work with the work of other Sections to avoid delay and interference with other work.
- B. Nuisances: Keep dirt, dust, noise and other objectionable nuisance to a minimum. Use temporary enclosures, coverings and sprinkling, and combinations thereof, as

necessary to limit dust to lowest practicable level, except do not use water to the extent that it causes flooding or contaminated run-off.

- C. Traffic: Conduct work to ensure minimum interference with vehicular and pedestrian traffic, and to permit unencumbered access to site and adjacent properties.
 - 1. Do not close or obstruct streets, sidewalks, alleys or other public passageways without permission from authorities having jurisdiction.
 - 2. If required by governing authorities, provide alternate routes around closed and obstructed traffic ways.
- D. Utility Service: As far as possible, conduct work to ensure minimum interference with utilities to insure on site and off site operations are uninterrupted.
- E. Protections:
 - 1. Prevent movement and settlement of adjacent structures. Install temporary barriers, fences, guard rails, enclosures, shoring, bracing, planking, barricades, lights, warning signs and other protections required to protect structures, utilities, landscaping and other items that are to remain in place.
 - 2. Protect bench marks movements and reference points from displacement and damage; and if displaced or damaged, replace at no cost to the Owner.
 - 3. Install and maintain required bracing, shoring and supports when removing structural elements and be responsible for safety and support of structure. If safety of structure appears to be endangered, cease operations and immediately notify the Owner. Do not resume operations until safety is restored.

PART 2 - PRODUCTS

2.1 PROTECTIVE FENCING

- A. As accepted by Owner's Representative and as specified herein.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas in which work is to be performed. Report in writing to the Owner's Representative all prevailing conditions that will adversely affect satisfactory execution of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Survey of Existing Conditions: Record existing conditions, including underground utilities, etc. by use of measured drawings and preconstruction photographs.
- C. Starting work constitutes acceptance of the existing conditions and the Contractor shall then, at his expense, be responsible for correcting all unsatisfactory and defective work encountered.
- D. Install and maintain temporary fencing and other required protective devices and exclude construction activities from tree/shrub zones except as supervised by the Arborist / Owner's Representative.

- E. If access to tree/shrub zones cannot be avoided an intact four inch layer of mulch with minimum 1.25 inch thick, metal strap linked plywood shielding shall be maintained in the tree/shrub zone where heavy equipment will be operated.
- F. Locate and clearly flag trees and vegetation to remain or to be relocated, as diagrammed and noted in the Construction Documents.

3.2 TRENCH LOCATION CONFIRMATION IN ROOT ZONES

- A. Where utility line trenches, including irrigation mainlines and lateral line trenches, occur in Tree Protection Zones, Contractor shall layout exact proposed trench locations and review locations with the Owner's Representative. If in the opinion of the Owner's Representative it is found that, trench locations can be adjusted to avoid cutting root systems 2" and larger without affecting the designed function of lines and systems, the Contractor will not be required to Air Spade or Tunnel in order to install the utilities. Adjustment of trench locations to avoid cutting root systems shall be at no additional cost to the Owner.

3.3 CLEARING:

- A. Field Verification: Before removing non-designated trees, shrubs, stumps, bushes, vines, rubbish, undergrowth and deadwood as shown on the Drawings and as specified, obtain verification from Owner's Representative.
- B. Remove non-designated trees, shrubs, stumps, bushes, vines, rubbish, undergrowth and deadwood as well as fences and incidental structures that interfere with the construction as shown on the Drawings and as specified. Obtain verification from Owner's Representative prior to removal.

3.4 GRUBBING

- A. Remove all stumps and roots in their entirety, brush, organic materials and debris to bare earth except where otherwise required. Tree trunks shall be removed minimum depth of 2 1/2 feet below existing grade or finish grade, whichever is deeper.
- B. Stump grinding is an acceptable method of removal of roots and stumps of trees and shrubs; however, the chip-contaminated soil shall be replaced with approved clean planting soil in planting areas and with approved clean fill soil in all other areas.
- C. Backfill and compact voids excavated and open pits and holes resulting from removal operations. Comply with Earthwork Specification for backfill materials, compaction and installation methods. Unless required otherwise, in planting areas backfill holes with clean approved planting soil compacted to 90% relative compaction to a minus 12 inches below finish grade and 85% relative compaction for the top 12 inches, except as required elsewhere to a greater degree by Civil or Structural Engineer. In non-planting areas backfill holes with approved fill soil compacted to 95% relative compaction.
- D. When indicated, such materials as topsoil and leaf mold, or other organic materials above the ground surface suitable for use as mulch or topsoil, shall be salvaged and stockpiled.
- E. Remove grasses and weeds. Apply systemic weed killer and confirm weed kill prior to removal.

- F. Remove existing pavement within proposed planting areas in its entirety, including baserock.
- G. Remove existing pavement within proposed pavement areas to a depth sufficient to allow for the construction of the proposed pavement to the grades shown. Existing base material may be left in place and re-compacted as required where not conflicting with the new pavement section.

3.5 UTILITIES

- A. Contact local utility companies 48 hours minimum prior to start of demolition work. Confirm verbal notices and written notices. Verify locations of all utilities entering site and their locations on site.
- B. Cooperate with the Owner's utility companies, adjacent property owners, and other building trades in maintaining, protecting, re-routing or extending utilities passing through work areas which serve structures located on project site and on adjacent properties.
- C. Verify that utilities that are to be removed, capped or abandoned are turned off, or are disconnected, or are re-routed to new locations before starting demolition.

3.6 DEMOLITION/REMOVAL

- A. General:
 1. Remove materials in an orderly and careful manner. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover and protect openings to remain.
 2. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 3. Repair or replace all removal work performed in excess to that required at no cost to the Owner. Repair or replacement shall match and equal construction, condition and finish existing at time of award of Contract.
 4. Removed and Reinstalled Items:
 - a. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 - b. Protect items from damage during transport and storage.
 - c. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- B. Remove following from locations to the extent required or directed for new construction. Removal of slabs and other structures shall include their footings and foundations. Removal of pavements shall include base rock and sub-structures.
 1. Slabs, equipment pads and sidewalks. Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
 2. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3. Asphalt, concrete paving, curbs, brick and block.
 4. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
 5. Fencing, including posts, fabric and footings.
 6. Electric utility poles, wires and down guys, including all underground wires and conduits occurring within removal areas.
 7. Designated utility services occurring within removal areas, including disconnection, capping and complete removal or abandonment.
 8. Buried tanks, complete with piping, footings, leach fields and foundations.
 9. Trees and their roots to a minimum of 30 inches below existing grade.
 10. Miscellaneous structural elements which interfere with the new construction and as directed by the Owner's Representative.
- C. Cutting asphalt, concrete curb and concrete pavement:
1. All lines shall be marked and accepted by Owner's Representative before the cutting operation.
 2. Cut edges of pavement at 90-degree angle to the surface in a true and straight line in accordance with dimensions shown on the Drawings. Make cuts with a concrete saw, to a 1-1/2" minimum depth.
- D. Backfill and compact areas excavated and open pits and holes resulting from removal operations. Comply with requirements specified in Earthwork, Section 02200 for backfill materials, compaction and installation methods.
- E. Rough grade site within removal areas to meet adjacent contours and to provide positive drainage. Leave site in clean condition acceptable for performance of subsequent construction operations.
- 3.7 CLEANUP AND DISPOSAL, per Section 02500
- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
1. Transport trash, rubbish and debris daily from site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove and promptly dispose of contaminated, vermin-infested and dangerous materials encountered.
 4. Do not burn or bury materials on site.
- B. Clean excess soil may be distributed on site as accepted by Owner's Representative, if it does not adversely affect specified finish grades or percolation of water into planting soil.
- C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began
- D. Upon completion of work under this Section, remove all tools, equipment and temporary enclosures and structures.

- E. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during site preparation, by methods and with materials so as not to change existing function and warranties.

END OF SECTION

SECTION 02140 – DEWATERING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all labor, materials, and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of the Contract Documents.
- B. Dewatering systems shall be designed by the CONTRACTOR and shall be coordinated with the design of sheeting, shoring, and bracing for excavations.

1.2 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01300 - Submittals.
- B. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER. CONTRACTOR plan shall identify the location(s) where water is to be disposed at the plant. The disposal locations shall be approved by the ENGINEER.

1.3 QUALITY CONTROL

- A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.
- C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely on the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.
- B. The Geotechnical Report has concluded that groundwater may be expected within a few feet of the upper bedrock contact and could be encountered along fractures, faults, and contacts within the bedrock. Shallower groundwater should be expected during the winter months and following periods of heavy rain.
- C. The CONTRACTOR is advised that construction and demolition may require excavations in areas with permeable soils that may convey significant water into the bottom of the excavations and require dewatering from outside the excavation to bring the area groundwater level below the bottom of the excavation.
- D. The CONTRACTOR is advised that when ever an excavation is near the backfill of an existing pipeline, that existing pipeline bedding and pipe zone backfill is composed of permeable material that will convey significant water. The CONTRACTOR shall provide dewatering outside of the excavation to control this water.
- E. Dewatering for structures and pipelines shall commence as required to control the water level below the bottom of the excavation, and shall be continuous until such time as water can be allowed to rise in accordance with the provisions of this section or other requirements.
- F. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- G. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock at no cost to the Owner.
- H. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.
- I. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. The CONTRACTOR shall ensure that the subsurface soil is not being removed by the dewatering operation. If well points or wells are used, a permit from applicable State and/or Local Authorities shall be obtained by the CONTRACTOR, as required. Wells, well points and piezometers shall

be installed and removed or abandoned in accordance with State and/or Local requirements.

- J. The CONTRACTOR shall dispose of water from the Work to the treatment plant as described in the CONTRACTOR's dewatering plan. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER.
- K. Water from dewatering activities discharged to the plant shall be of a quality that meets the wastewater quality requirements as identified in the Owner's ordinances or regulations. The turbidity of water discharged to the plant shall not exceed 10 NTU. The flow shall be limited to 500 gpm unless otherwise approved by the Owner for short defined durations. The dewatering activities shall not cause any nuisance issues associated with the disposal of groundwater. The CONTRACTOR shall be responsible for sampling and disposal of sediments collected in settling tanks and other waste materials related to groundwater disposal.
- L. The CONTRACTOR shall test water from dewatering activities to ensure compliance with the turbidity requirement. CONTRACTOR shall test water anytime modifications are made to dewatering systems and a least once per day during the duration of dewatering activities. The CONTRACTOR shall notify the Construction Manager when sampling and testing are to be completed to allow for Construction Manager inspection. The CONTRACTOR shall provide sampling points for the Owner to collect representative samples for Owner testing.
- M. The Owner will test water from dewatering activities to ensure compliance with water quality requirements. The CONTRACTOR shall provide sampling points for the Owner to collect representative samples required for testing.
- N. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent floatation or movement of structures, pipelines and sewers.
- O. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the Work and all costs thereof shall be included in the various contract prices of the Bid Forms, unless a separate bid item has been established for dewatering.
- P. Groundwater that contains hazardous material or designated materials, or otherwise does not meet the water quality requirements for discharge to the Owner's collection system shall be transported to an appropriate licensed liquid waste disposal facility. Compensation for disposal of groundwater to other than the Owner's system shall be subject of a negotiated change order in accordance with the Contract Documents.
- Q. Damage caused by dewatering shall be repaired at the CONTRACTOR's cost.

END OF SECTION

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SECTION 02200 – EARTHWORK

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. This Section includes all earthwork required for construction of the Work. Such earthwork shall include, but not be limited to the loosening, removing, loading, transporting, depositing, and compacting in its final location, of all materials wet and dry, as required for the purposes of completing the Work specified in the Contract Documents. The Work shall also include the supporting of structures and utilities above and below the ground; all excavation and backfilling around structures and utilities and all excavation and backfilling of trenches and pits; the disposal of excess excavated materials; borrow and importing of materials to make up deficiencies for fills; and all other incidental earthwork, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. In preparing these Contract Documents, the Engineer has relied upon the following geotechnical work:
 - 1. A Geotechnical Report has been prepared for this project. The report is entitled Geotechnical Investigation, Treatment Plant Upgrade Project, Sausalito-Marin City Sanitary District, Sausalito, California, Miller Pacific Engineering Group, March 2014.
 - 2. The geotechnical report is available in electronic format separately upon request from the District.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Specifications, Codes and Regulations:
 - 1. California Department of Transportation Test Method Nos. 301 and 217.
 - 2. Caltrans Standard Specifications.
 - 3. U.S. Corp of Engineers, Specification CW-002215.

1.4 CONTRACTOR SUBMITTALS

- A. General: Contractor shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of 01300 - Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300, Contractor shall submit the following:
 - 1. The Contractor's attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The Contractor, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to

the Owner and shall be in receipt of the Owner's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California. Shoring system shall be in accordance with Section 02390 – Shoring.

2. The Contractor shall submit a copy of the excavation permit issued by the California Department of Industrial Safety.
3. The Contractor shall submit samples of all materials proposed to be used in the work in accordance with the requirements. Sample sizes shall be as required by the Owner's testing laboratory.

- C. As necessary, a revised grading and drainage plan shall be submitted to address use of surplus materials.

1.5 QUALITY ASSURANCE

- A. General: It shall be the responsibility of the Contractor to accomplish the specified compaction for backfill or other earthwork. Soil testing to confirm compliance with the Contract Documents shall be performed and paid for by the Owner. In the event of non-compliance, retesting shall be performed by the Owner at the cost of the Contractor.
- B. Where soil material is required to be compacted to a percentage of maximum dry density, the maximum dry density at optimum moisture content shall be determined in accordance with ASTM D1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density shall be determined in accordance with ASTM D4253 and ASTM D4254. Field density in-place tests shall be performed in accordance with ASTM D1556, ASTM D2922, or by such other means acceptable to the Engineer.
- C. In case the tests of the fill or backfill show non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner and shall be at the Contractor's expense.
- D. Particle size analysis of soils and aggregates shall be performed using ASTM D422.
- E. Determination of sand equivalent value shall be performed using ASTM D2419 or California Test Method No. 217, State of California, Department of Transportation.

PART 2 PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

- A. General: Fill and backfill materials shall be suitable selected or processed clean, fine earth, rock, or sand, as specified herein, and shall be free from grass, roots, brush, or other vegetation. Fill and Backfill materials shall not contain rocks or lumps larger than 6 inches in greatest dimension and shall contain no more than 15 percent of particles larger than 2.5 inches. Fill and backfill materials to be placed within 12 inches of any

structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3/4 inches.

- B. Suitable Materials: Materials not defined as unsuitable below are defined as suitable materials and may be used in fills, backfilling, and embankment construction subject to the indicated limitations.
- C. Suitable materials may be obtained from on-site excavations, may be processed on-site materials, or may be imported. If imported materials are required by this Section to meet the quantity requirements of the project, the Contractor shall provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. The Contractor shall designate the proposed import sources in advance and shall provide representative source samples to be tested prior to acceptance and use. Imported material shall meet the requirements of Section 02600 – Importing Soils and Fill Material.

2.2 SUITABLE MATERIALS

- A. Aggregate Base, Caltrans Class 2
 - 1. Caltrans Class 2 Aggregate Base shall conform to Caltrans Standard Specifications, Section 26-1.02A “Class 2 Aggregate Base”.
- B. Permeable Base, Caltrans Class 2
 - 1. Caltrans Class 2 Permeable Base shall conform to Caltrans Standard Specifications, Section 68-1.025.
 - 2. Unless otherwise shown, Geotextile Filter Fabric is not required when using this material in pipe trenches.
- C. Permeable Base, Caltrans Class 1, Type A
 - 1. Caltrans Class 1, Type A, Permeable Base shall conform to Caltrans Standard Specifications, Section 68-1.025
 - 2. Unless otherwise shown, geotextile fabric is not required when using this material beneath structures.
- D. Coarse Drain Rock
 - 1. Coarse Drain Rock shall be clean rock conforming to the following gradation requirements:

Sieve Size	Percent Passing
2-inch	100
1-1/2-inch	90-100
3/4-inch	0-30
3/8-inch	5-20
No. 200	0-4
 - 2. When used as a bedding / backfill material in pipe trenches or beneath structures, Coarse Drain Rock shall be completely encapsulated in Geotextile Filter Fabric

with minimum 12-inch laps to prevent contamination of the rock by surrounding soils.

E. Gravel

1. Gravel (crushed rock) shall be free of deleterious material and free from slaking or decomposition under the action of wetting and drying, meeting the following gradation requirements:

Sieve Size	Percent Passing
1-inch	100
3/4-inch	90-100
No. 4	0-10
No. 200	0-2

2. Gravel (crushed rock) material shall have a durability index of not less than 40.

F. Sand Backfill: Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

G. Trench Plug Material: Low permeability, non-dispersible clay fill material having a minimum plasticity index of 25.

H. Fill Material

1. Fill Material shall be native or import material that is free of organic matter, has a liquid limit of less than 40, a plasticity index of less than 20, a minimum R-value of 20, and conform to the following gradation requirements:

Particle Size	Percent Finer by Dry Weight
4-inch	100
No. 4 sieve	20-100
No. 200 sieve	0-50

I. Controlled Density Fill

1. Controlled density fill mix shall be composed of a cementitious material, water, fine and coarse aggregate, and an admixture. The cementitious material shall be Portland cement in combination with fly ash. The admixture shall be an air-entraining agent. The proportions of all material used in the controlled density fill shall conform to the mix design. Controlled density fill shall have an unconfined compressive 28-day strength from 50 psi to a maximum of 150 psi.
2. Aggregate content: Aggregates need not conform to ASTM C33. Any aggregates that produce performance characteristics of the control density fill may be submitted for approval. Control density fill mixture shall contain no aggregate that is larger than 3/8-inch. The amount of material passing a No. 200 sieve shall not exceed 12 percent. No plastic fines shall be present.
3. Air content: The air content by volume based on measurement made immediately after discharge from the mixer shall be determined by ASTM C231. The total

calculated air content of the sample prepared in accordance with ASTM C231 shall not exceed 6 percent.

4. Mix Design shall be as follows:

Material	Weight	Sp.Gr.	Abs.Vol.
Cement	30 lbs.	3.15	0.152
Fly Ash	300 lbs.	2.30	2.090
Water	317 lbs.	1.00	5.08
Coarse aggregate	1645 lbs.	2.68	8.76
Fine aggregate	1465 lbs.	2.68	9.835
Admixture	4 oz.	---	1.08
Total	3757 lbs.	---	27.0 cu.ft.

5. Provide the Engineer with delivery tickets for each truck load that shows the control density fill mix, the batch size, and the time batched.
6. Materials
- a. Cement shall conform to ASTM C150, Type II. Fly ash shall conform to ASTM C618, Class F.
 - b. The fly ash shall not inhibit the entrainment air.
 - c. Air entraining admixture shall conform to ASTM C260.
 - d. Fine aggregate - No. 1 concrete sand. Coarse aggregate - No. 2, 3/8-inch pea gravel.
7. Controlled density fill shall be batched by a ready mixed concrete plant and mixed and delivered to the jobsite by means of transit mixing trucks.
- a. No equipment or traffic shall be allowed on the controlled density fill until the surface of the controlled density fill will withstand the weight of equipment or traffic without displacement or damage. If necessary to prevent displacement or damage, provide steel trench plates that span the trench or other means that prevent equipment or traffic contact with controlled density fill.
 - b. Take all precautions necessary to prevent the uplift or floating of the pipeline prior to the completion of the backfilling operation.

J. Low Expansive Fill

1. Low Expansive Fill material shall meet the following gradation requirements:

Sieve Size	Percent Passing
3"	100
3/4 "	60 – 100
No. 4	40 – 100
No. 200	10 – 40

2. Low Expansive Fill material shall meet the following quality requirements:

Parameter	Requirement
Plasticity Index	Less than 12
Liquid Limit	Less than 30
Expansion Index (UBC 18-2)	Less than 20

3. The Low Expansive Fill material shall consist of a soil or soil rock mixture that is free of organic material or other deleterious substances.

K. Retaining Wall Drainage: Caltrans Class 1, Type B, Permeable Material, wrapped in filter fabric.

L. Topsoil

1. Topsoil shall conform to Caltrans Standard Specifications, Section 20-2.01 "Topsoil".

2.3 GEOTEXTILE FILTER FABRIC

A. The geotextile filter fabric shall be a non-woven material consisting of polyester, nylon, or polypropylene filaments formed into a stable network. The fabric shall be permeable, not act as a wicking agent, be inert to commonly encountered chemicals, be rot proof, and resistant to damage due to ultra-violet light.

B. The geotextile fabric shall also conform to the following physical properties:

Property	Test Value	Test Method
Weight	5.4 oz./yd. (min.)	ASTM D3776
Grab tensile strength	150 lb. (min.)	ASTM D4632
Elongation at break	50 percent (max.)	ASTM D4632
Puncture strength	80 lb. (min.)	ASTM D4833
Burst strength	300 psi (min.)	ASTM D3786
Apparent opening size	#70 (max.)	ASTM D4751
Permeability	1.0 sec ⁻¹ (min.)	ASTM D4491
UV resistance	70 percent (min.)	ASTM D4355

C. Filter fabric shall be Mirafi 140 N or equal.

D. Stabilization fabric shall be Mirafi 700X or equal.

2.4 UNSUITABLE MATERIAL

A. Unsuitable fill materials include the materials listed below.

1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.
2. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.
4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing on-site soils.
5. Topsoil, except as allowed below.
6. Material that does not meet the requirements of Section 02600 – Importing Soils and Fill Material.

2.5 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

- A. The Contractor shall use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.
- B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, the Engineer shall be immediately notified. In case of conflict between types of pipe embedment backfills, the Contractor shall use the agency-specified backfill material if that material provides a greater degree of structural support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, the Contractor shall use the agency-specified backfill material if that material provides the greater in-place density after compaction.
- C. Fill and backfill types shall be used in accordance with the following provisions:
 1. Embankments:
 - a. Embankment fill and earthwork shall be constructed of Fill Material obtained from on-site excavations/borrow sites or imported off-site material, provided that the minimum compaction requirements specified herein can be met, or Low Expansive Fill.
 2. Pipelines (See drawing detail C240)
 - a. Where groundwater is not present, the pipe bedding and pipe zone shall be Aggregate Base, Caltrans Class 2, unless otherwise specified.
 - b. Where groundwater is present, the pipe bedding shall be Coarse Drain Rock and pipe zone shall be Aggregate Base, Caltrans Class 2.
 - c. Pipe bedding and pipe zone backfill for tape-wrapped steel pipe shall be Controlled Density Fill.
 - d. Pipe trench over-excavation and stabilization zone fill shall be Coarse Drain Rock wrapped in Geotextile Filter Fabric to provide a stable working surface in wet trench conditions. Where conditions are not wet, the backfill material shall consist of the same material specified for the pipe zone.
 - e. Trench backfill shall consist of Fill Material specified herein or Low Expansive Fill.

- f. For pipelines under structures, trench backfill shall be the same material as used in the pipe zone, except where concrete encasement is required as indicated on the Drawings.
 - g. Trench surface finish shall be in accordance with detail C242. Final backfill material for pipelines under pavements, sidewalks, curbs, gutters, equipment pads and other surface improvements shall be Caltrans Class 2 Aggregate Base unless otherwise specified. Final backfill under areas not paved shall be the same material as that used for trench backfill, except that topsoil material shall be used for final backfill in landscaped areas unless otherwise indicated on the Drawings.
 - h. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a Number 4 sieve, Trench Plug Material shall be provided at maximum intervals of 200 feet unless indicated otherwise. Trench Plug Material shall also be provided at edges of structure footings where pipeline passes beneath structures, with the Trench Plug Material lapping the footing edge to provide a complete seal against migration of water.
3. Structures
- a. Backfill around structures shall be Fill Material.
 - b. Drain Rock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Class 2 Permeable Base without Geotextile Filter Fabric, or Coarse Drain Rock completely encapsulated in Geotextile Filter Fabric.
 - c. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Caltrans Class 2 Aggregate Base shall be used as shown on the Drawings.
 - d. Under structures where groundwater must be removed to allow placement of concrete, Coarse Drain Rock completely encapsulated in Geotextile Filter Fabric shall be used.
 - e. Under all other structures, Caltrans Class 2 Aggregate Base shall be used.
4. Aggregate base materials under pavements, sidewalks, curbs, gutters, equipment pads and other surface improvements shall be Caltrans Class 2 Aggregate Base constructed to the thicknesses indicated.
5. Topsoil (outside of the Fill Material classification and suitable for landscaping), stripped from the site may be used to achieve final specified grades in specified areas. Upon approval by the Engineer, topsoil may also be used in other areas at the Work site. Excess topsoil that cannot be used at the site shall off hauled for disposal unless otherwise approved by the Construction Manager.

2.6 MATERIALS TESTING

- A. All soils testing shall be in accordance with Section 01400. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.

- B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.
- C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.
- E. The testing for chloride, sulfate, resistivity, and pH will be done in accordance with California Test Methods 532 and 643 of the California Department of Transportation.

PART 3 EXECUTION

3.1 EXCAVATION – GENERAL

- A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
 - 1. Excavation shall be made to such widths as will give safe room for construction of structures and utilities including bracing, supporting, pumping, and draining. The bottom of the excavations shall be rendered firm and dry.
 - 2. Some portions of the structures or pipelines to be built under this Contract will be closely adjacent to existing foundations, structures, pipelines, and utilities. Therefore, when performing excavation, the Contractor shall take all reasonable care to protect free from damage any foundations, walls, projecting reinforcement, pipes, utilities, and any other items encountered. Contractor shall promptly draw to the notice of the Engineer any conditions that may prevent him/her from providing such protection.
- B. Removal and Exclusion of Water: The Contractor shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from all excavations as specified in Section 02140 - Dewatering.
- C. Erosion Control: Contractor shall install 4" of California certified Weed Free Rice Straw. Straw shall be covered with 600 Gr Coir fabric. Coir shall be overlapped by a minimum 12" at all seams. Fabric shall be toed in to the top and bottom of the slope as per GGNRA BMP Handbook. Fabric shall be securely staked using a metal U-stake or wooden stake depending on finish site conditions. Stakes shall be installed along all seams, as well as throughout erosion control installation to secure fabric firmly and ensure not straw movement.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

- A. Excavation Beneath Structures: Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the subgrade layer. Where indicated, areas beneath structures or fills shall be over-excavated. After the required excavation or over-excavation has been completed, the exposed surface shall be brought to optimum moisture content, and rolled with heavy compaction equipment to meet the following requirements:
1. Structural fills less than five feet thick should be moisture conditioned above the optimum moisture content and uniformly compacted to a minimum of 90 percent relative compaction.
 2. Structural fills in excess of five feet should be moisture conditioned above the optimum moisture content and uniformly compacted to a minimum of 92 percent relative compaction to reduce the potential for significant settlement.
- B. Excavation Beneath Embankments: The subgrade areas beneath embankments shall be excavated to remove not less than the top 8 inches of native material, or as otherwise specified, and where such subgrade is sloped, the native material shall be benched. When such over-excavation is indicated, both over-excavation and subsequent backfill to the required grade shall be performed by the Contractor. When such over-excavation is not indicated but is ordered by the Engineer, such over-excavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 8 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.
- C. Excavation Beneath Concrete Hydraulic Structures: Excavation under tanks or reservoirs shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the structures upon which fill is to be placed shall be scarified to a depth of 8 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.
- D. Excavation Beneath Paved Areas: The subgrade areas beneath paved areas shall be excavated to remove not less than the top 8 inches of native material, or as otherwise specified, and where such subgrade is sloped, the native material shall be benched. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the top 8 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 90 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.
- E. Notification of Engineer: The Contractor shall notify the Engineer at least 48 hours in advance of completion of any structure excavation and shall allow the Engineer a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

- A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.
- B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding. Excavations for pipe bells and welding shall be made as required.
- C. Open Trench: All trenches in existing Plant roadways shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates of 1-inch minimum thickness adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. The above requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway, designated access, or occupied structure. In such cases, however, barricades and warning lights meeting safety requirements shall be provided and maintained. The Engineer may designate a passage to be provided at any point deemed necessary.
- D. Trench Over-Excavation: Where trenches are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.
- E. Over-Excavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be over-excavated beyond the depth and/or width shown. Such over-excavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Over-excavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the over-excavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made to the Contractor. Said additional payment will be made under separate unit price bid items for over-excavation if such bid items have been established; otherwise payment will be made in accordance with Section 01025.
- F. Utility trenches should be backfilled with soil compacted to at least 90 percent relative compaction. A minimum of 4 inches of sand (or other approved pipe bedding material) should be placed in the bottom of the trench excavation. The sand should be continuous around the utility pipe and extend at least 4 inches above the top of the pipe. The sand should be compacted to 90 percent relative compaction.
 - 1. Intermediate backfill above the sand to the subgrade elevation may be select on-site material or Caltrans Class 2 Aggregate Base. The backfill materials should be placed in uniform lifts no thicker than 8 inches, moisture conditioned to near optimum moisture content, and compacted to the specified degree of compaction.
 - a. Within roadway and driveway areas, the intermediate backfill should be compacted to at least 90 percent relative compaction with the uppermost 12 inches compacted to 95 percent relative compaction, in accordance with ASTM D-1557.
 - b. In non-structural (landscape) areas, the trench backfill should be constructed to at least 85 percent relative compaction.
- G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved

horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

- H. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally. The Contractor shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

3.4 OVER-EXCAVATION NOT ORDERED OR INDICATED

- A. Any over-excavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed by the Contractor at no additional cost to the Owner.

3.5 EXCAVATION IN VICINITY OF TREES

- A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer. Contractor shall hand dig within the drip line.

3.6 ROCK EXCAVATION

- A. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and un-stratified masses which cannot be removed without systematic drilling and blasting; (3) concrete or masonry structures which have been abandoned; and (4) conglomerate deposits which are so firmly cemented that they possess the characteristics of solid rock and which cannot be removed without systematic drilling and blasting.
- B. Hard rock shall be defined as rock excavation at a production rate of less than 1 cubic yard per hour using a large sized hydraulic excavator (net power of at least 180 hp and minimum operating weight of 80,000 lbs) operating at full power with carbide tipped rock teeth on ¾-yard bucket. Any rock conditions encountered to be claimed as hard rock need to be observed and approved in the field by the Engineer prior to being accepted as hard rock. The unit rates established in the Schedule of Bid Items will be used for payment of all hard rock excavation, regardless of actual final excavation volume.
- C. Explosives and Blasting: Blasting will not be permitted unless determined that no other means are practical as determined by the Contractor, Owner, and Engineer. For use of explosives, Contractor shall submit a blasting plan defining the type and quantity of explosives and electronic monitoring of surrounding facilities for review by the Engineer. Blasting may only be performed by an experienced and California licensed blaster.

3.7 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. Excess material shall be handled in accordance with Section 01014.
- B. The Contractor shall remove and dispose of all excess excavated material including placement and/or hauling.

- C. The Contractor shall obtain all required permits, landowner, and agency approvals for disposal of excess excavated material and shall pay all costs associated with the removal and disposal.
- D. Surplus Material that can be used for compacted fill or backfill
 - 1. Surplus soils that can be used for fill or backfill shall be placed at the site in the designated Contractor Staging Area in accordance with the drawings. The Contractor shall submit a revised grading and drainage plan if surplus material is to be placed in this area.

3.8 BACKFILL - GENERAL

- A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any cast-in-place concrete structure until all portions of structure walls and associated roof systems have been completed and concrete meets 70% of its 28 day compressive strength per Section 03300. Backfill around water retaining structures shall not be placed until the structures have been tested in accordance with Section 02620, and the structures shall be full of water while backfill is being placed.
- B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.
- C. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.9 PLACING AND SPREADING OF BACKFILL MATERIALS

- A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that when compacted each layer shall not exceed 6 inches in thickness.
- B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.
- C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
- D. Where the backfill material moisture content is too high to permit the specified degree of compaction the material shall be dried until the moisture content is satisfactory.

3.10 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS

- A. Compacted Fill should be conditioned to near the optimum moisture content. Properly moisture conditioned and cured materials should subsequently be placed in loose horizontal lifts of 8 inches thick or less, and uniformly compacted in accordance with Section 3.1, H, to produce a firm non-yielding surface. The upper six inches of

pavement subgrade (i.e. access roads) should be compacted to a minimum 95 percent relative compaction to provide a smooth, uniform, unyielding surface.

- B. Each layer of fill and backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the specified percentage of maximum density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content. Lightweight tampers or vibrating plate compactors shall be used in pipeline and utility trenches to prevent damage to existing or new utilities. All areas to receive fill shall be scarified to a minimum depth of 8 inches and compacted to a minimum 90 percent of maximum dry density.
- C. Coarse Drain Rock shall be compacted by means of at least 2 passes from a flat plate vibratory compactor.
- D. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least two feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.
- E. Compaction of backfill adjacent to all subgrade structure walls shall follow a pattern of compaction that begins at the wall face and progresses outward to the outside edge of the excavation before beginning a new lift.
- F. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.
- G. Flooding, ponding, or jetting shall not be used.
- H. Compaction Requirements. The following compaction test requirements shall be in accordance with ASTM D1557 or in accordance with ASTM D4253 and D4254 as applicable. Where agency or utility company requirements govern, the highest compaction standards shall apply. All fill and backfill materials shall be compacted to a minimum of 90 percent of maximum dry with the exception of the following:

Location or Use of Fill	Percentage of Maximum Density
Pipe zone backfill for flexible pipe.	90
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	90
Pipe zone backfill for Steel Yard Piping	90
Pipe zone backfill for rigid pipe	90
Pipe bedding and over-excavated zones under bedding for rigid pipe.	95
Final backfill, beneath paved areas or structures.	95
Final backfill, not beneath paved areas or structures.	90
Trench zone backfill, beneath paved areas and structures, including trench plugs.	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	90
Embankments and fills.	95
Embankments and fills beneath paved areas or structures.	95
Backfill beneath structures and hydraulic structures.	95
Backfill and fill around structures	95
Topsoil	80
Caltrans Class 2 Aggregate Base	95
Caltrans Class 2 Permeable Base	95
Caltrans Class 1 Permeable Base	90

3.11 PIPE AND UTILITY TRENCH BACKFILL

- A. Pipe Backfill: The pipe zone is defined as that portion of the vertical trench cross-section from the bottom the pipe to a plane at a point 12 inches above the top surface of the pipe. The pipe bedding is defined as that portion of backfill material between the trench subgrade and the bottom of the pipe. The pipe zone and pipe bedding are shown in detail C240.
- B. After compacting the bedding, the Contractor shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.
- C. The pipe zone shall be backfilled with the specified backfill material as specified in the Contract Documents. The Contractor shall exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.
- D. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. The Contractor shall not displace the pipe or backfill while the shield is being moved.
- E. Trench Backfill: After the pipe zone backfill has been placed as specified above, backfilling of the trench backfill area may proceed. The trench backfill area is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at the finished surface grade, or if the trench is under pavement below the roadway subgrade.

- F. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.12 FILL AND EMBANKMENT CONSTRUCTION

- A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 8 inches, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the Engineer, each layer shall not exceed 6 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.
- B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 8:1, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. A minimum of 3 feet into firm bedrock shall be removed and re-compacted as the embankment or fill is brought up in layers. Material thus cut shall be re-compacted along with the new material at no additional cost to the Owner.
 - 1. Fill slopes should be inclined no steeper than 2:1. Fill slopes steeper than 2:1 will require internal reinforcement and need to be specifically designed. For fill slopes steeper than 2:1, consult the Geotechnical Engineer.
 - 2. Hillside or fill slopes 2:1 or flatter shall be prepared in accordance with Paragraph A, above.
- C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe. Heavy construction equipment shall maintain a minimum distance from the edge of the trench equal to the depth of the trench until at least 4 feet of fill over the pipe has been completed.

3.13 FIELD TESTING

- A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.
- B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the Engineer.
- C. In case the test of the fill or backfill show non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to insure compliance.

Subsequent testing to show compliance shall be by an Owner's testing laboratory at the Contractor's expense.

- D. The Contractor shall provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.

END OF SECTION

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SECTION 02210 – CONTROLLED LOW STRENGTH MATERIAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish all material for Controlled Low Strength Material (CLSM) in accordance with the provisions of this Section and shall mix, place, finish and do all other work as required by this Section to produce a cementitious hand excavatable mixture of aggregate, cement, pozzolan, water, and admixtures used as structure backfill, pipe zone backfill, or pipe abandonment fill in accordance with the Contract Documents.
- B. The Contractor is hereby advised that flotation or displacement of the pipe could occur during installation of the CLSM. The Contractor shall make necessary provisions to ensure that the pipe is installed according to the alignment and grade specified in the Contract Drawings. Any pipe that is floated shall be removed and replaced at the Contractor's expense.

1.2 CONTRACTOR SUBMITTALS

- A. The Contractor shall prepare and submit information on CLSM in accordance with Section 01300, Submittals and the requirements herein.
- B. Mix Design: Prior to beginning the work, the Contractor shall submit to the District for review, CLSM mix designs which shall show the proportions and gradations of all materials proposed for each class and type of CLSM specified herein. The mix designs shall be tested by an independent testing laboratory for properties specified herein and at the Contractor's expense. The results of the independent testing laboratory shall be submitted with the CLSM mix designs. The results of at least five (5) separate tests within the previous 12 months shall be submitted to the District.

1.3 QUALITY ASSURANCE

- A. General:
 - 1. All field sampling and testing during the work will be done by a testing laboratory of the District's choice at the District's expense except as otherwise noted.
 - 2. In case the tests of the CLSM show non-compliance with the specifications, the Contractor shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be at the Contractor's expense.
- B. Compressive Strength: The compressive strength will be determined in accordance with ASTM C 4832.

2.1 CONTROLLED LOW STRENGTH MATERIAL (CLSM) GENERAL

- A. CLSM shall be a hand excavatable mixture of cement, pozzolan, coarse and fine aggregate and water which has been mixed in accordance with ASTM C 94.

2.2 USE OF CONTROLLED LOW STRENGTH MATERIAL

- A. CLSM shall be of a non-segregating consistency that readily flows when used for pipe abandonment and structure cavity fill.
- B. CLSM for trench backfill and/or trench plugs (trench dams) shall readily flow and shall meet the specified strength requirements.

2.3 CEMENT

- A. Cement shall be Type V in accordance with the requirements of ASTM C 150.

2.4 POZZOLAN

- A. Pozzolan shall be added to improve the flowability and shall be Type F in accordance with the requirements of ASTM C 618.

2.5 AGGREGATE

- A. Aggregate shall consist of a well-graded mixture of crushed rock, or sand. The gradation of the CLSM aggregate shall be:

B.	Sieve Size	C.	Percentage Passing (by dry weight)
D.	½ inch	E.	100
F.	3/8 inch	G.	70-100
H.	No. 4	I.	40-80
J.	No. 200	K.	0-12

L.

2.6 ADMIXTURES

- A. Air entraining agent shall be added to improve the workability and shall be in accordance with the requirements of ASTM C 260.
- B. Water reducing agent shall be added to improve the workability and shall be in accordance with the requirements of ASTM C 494.

2.7 WATER

- A. Water shall be clean and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.

2.8 CONTROLLED LOW STRENGTH MATERIAL

- A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water batched by a ready mix concrete plant and delivered to the WORK by means of standard transit mixing trucks. The mixture shall produce a cementitious hand excavatable material. The material supplied shall be Controlled Density Fill

supplied by Pozzolan International, Flowable Compacting Fill by RMC Lonestar, or approved equal.

- B. The actual mix proportion, slump, and water reducing agent shall be determined by the Contractor to meet the uses specified herein. At a minimum, slump shall be 7-inches for pipe zone backfill. All mix designs shall be approved by the District prior to installation.
- C. The entrained air content shall be a minimum of 8 percent and a maximum of 20 percent as required by the Contractor to meet the uses specified herein.
- D. The minimum 28-day compressive strength shall be 100-psi and the maximum 28-day compressive strength shall be 120-psi.

3.1 PREPARING PLACEMENT FOR CLSM

- A. The subgrade and compacted fill and/or trench to receive CLSM shall be complete and acceptable in accordance with Section 02200, Earthwork.

3.2 MIXING AND DELIVERING CLSM

- A. CLSM shall be batched by a ready mix batch plant acceptable to the District.
- B. CLSM shall be delivered to the Work in standard transit mix trucks.

3.3 PLACING CLSM

- A. CLSM shall be delivered in place by means of tailgate discharge, conveyor belts, concrete pump, or other means acceptable to the District.
- B. CLSM shall be directed in place by means of a vibrator, shovel or rod to ensure that all voids, crevices, pockets and under pipe haunches are filled with CLSM. Care shall be taken to avoid over-consolidation of the material and separating the coarse and fine aggregate.
- C. CLSM shall be continuously placed against undisturbed in-situ earth material unless otherwise approved by the District. Where new CLSM must be placed against existing CLSM, the surface shall be clean of all loose and foreign material. The surface of existing CLSM shall be soaked a minimum of 1 hour before placement of fresh CLSM. No standing water will be allowed before starting placement of fresh CLSM.
- D. When placing CLSM for trench cutoff walls (trench plugs), the Contractor shall ensure that no voids exist around the pipe barrel and that the CLSM completely fills the trench width, including keyways, for the full depth required, as shown.

3.4 FINISHING CLSM

- A. The finish surface of CLSM shall be smooth and to the grade shown or directed by the District. Finishing by wood float, steel trowel or other similar methods is not required.

3.5 PROTECTING CLSM

- A. CLSM shall be protected from running water, rain, freezing, or other conditions that could damage the material until the material has been accepted and final fill complete.

3.6 TRENCH BACKFILL

- A. No equipment, traffic, or backfill shall be allowed on the CLSM until the CLSM installation passes the ball drop test specified in ASTM D 6024. If necessary, the Contractor shall provide steel trench plates that span the trench, as specified in Section 02200, Earthwork, until the CLSM has reached the required strength.

B. END OF SECTION

SECTION 2286 SOIL NAILS

PART 1.0 - GENERAL

1.01 SCOPE OF WORK

Description - The work under this section includes the material, equipment, and labor necessary to install and test soil nails, in the locations and to the depths shown on the plans.

1.02 DEFINITIONS

Soil Nail - Anchors comprised of a deformed steel bar grouted into a near horizontal drilled hole, together with appropriate corrosion protection and anchorage hardware for the purpose of reinforcing a slope by transferring tensile loads into the soil and/or rock formation.

Design Load (DL) - The final maximum effective capacity of the soil nail after allowance for time dependant losses or gains.

Proof Load (PL) - The temporary pre-stressing load at which the soil nail is tested.

Verification Load (PL) - The temporary pre-stressing load at which verification soil nails are tested.

Kips ("k") - A unit of load equal to 1,000 pounds.

1.03 SUBMITTALS

- A. General – Submittals shall conform to Section 46-1.01C of the latest edition of Caltrans Standard Specifications.

1.04 QUALITY ASSURANCE

- A. Notification - No site work shall be performed without notification of the Engineer at least 2 full working days prior to commencement of work.
- B. Site Information - The Contractor shall satisfy himself as to the nature and quantity of materials likely to be encountered at the site and other work to be performed, and any differences between site conditions shown on the drawings and the actual conditions immediately prior to commencement of work.
- C. Inspection and Testing - The Contractor shall provide the Engineer with access to the work and all reasonable facilities for inspecting and checking the work.
- D. Conformance of Materials - All materials used in the construction of the soil nail wall shall conform to the most recent version and relevant standards of the American Society

for Testing and Materials (ASTM), American Concrete Institute (ACI), International Association of Foundation Drilling (ADSC), Caltrans Standard Specifications (Caltrans), or other standards specified by the Engineer.

PART 2.0 – PRODUCTS

- 2.01 Soil Nails - Shall be steel thread bars as designated on the plans and manufactured expressly for use as soil nails or tiebacks by:

Dywidag -Systems International, Long Beach, California;
Other supplier approved in advance by the Engineer.

- 2.02 Thread Bar - Shall conform to the following:

- A. Grade 75 shall conform to ASTM A615
- B. Grade 150 shall conform to ASTM A722

- 2.03 Bearing Plates and Hardware - Bearing plates, headed studs, washers, nuts, and all other hardware shall conform to the manufacturer's recommendations and applicable ASTM standards.

- 2.04 Corrosion Protection - Corrosion protection shall be double corrosion protection as recommended by the manufacturer and as shown on the plans.

Unless otherwise required, double corrosion protection shall consist of grouting the entire length of the soil nail within a corrugated Polyvinyl Chloride (PVC) sheath.

For soil nails installed below elevation +10 feet, bearing plates, headed studs, washers, nuts and other hardware shall be epoxy-coated in accordance with ASTM A934 with a minimum epoxy coating thickness of 12 mils. Any portions of the epoxy coating that are scratched, nicked or otherwise disturbed during construction shall be touched-up with coal tar epoxy coating, as approved by the Engineer. Soil nails installed above elevation +10 feet do not require epoxy coating.

- 2.05 Corrosion Inhibitor - Shall be an organic compound with corrosion inhibition, moisture displacing and self-healing properties as recommended by the manufacturer. It shall be physically stable and non-reactive with concrete, steel and sheathing material.
- 2.06 Accessories - Plastic sheathing, centralizers, spacers, and other accessories of steel or plastic which are necessary for the installation shall be as recommended by the manufacturer. Wood, paper or other organic material shall not be used.
- 2.07 Cement Grout - Shall be made of non-shrinking portland cement conforming to ASTM C-150. Chemical additives that can control bleed and accelerate or retard set, may be used. Water/cement ratio shall be in the range of 0.4 to 0.5. The grout workability must be suitable for uniform placement. Minimum compressive 30 day strength (f'c) shall be 4000 psi, unless otherwise shown on the plans.

PART 3.0 – EXECUTION

3.01 Pre-Construction Meeting - A pre-construction meeting shall be held at the site. The Contractor shall present his proposed construction method and schedule. The meeting will include the Contractor, the Engineer, and Owner's representative.

3.02 Equipment - The drilling equipment may be percussion, rotary or other type capable of drilling a hole free of protrusions through soil and rock to the dimensions shown on the drawings.

Grout mixing equipment shall be capable of continuous mechanical mixing that will produce a uniform and thoroughly mixed grout. Grout pumping equipment shall be capable of grouting at a pressure of at least 150 psi.

3.03 Alignment - All excavations and holes shall be carefully located and aligned by the Contractor. The drilled hole location shall not deviate more than 2 inches in any direction from the center location shown on the plans. The vertical angle shall be within 3 degrees of the vertical and horizontal orientation shown on the plans.

3.04 Dimensions - The diameter of the auger bit, or the inside diameter of the casing, shall be at least 4 inches and equal to or larger than the diameter shown on the plans. The soil nail lengths shown on the plans are for bidding purposes. Adjustments in location, direction and length may be required by the Engineer.

3.05 Excavation - The excavation (drilling) shall be performed under the intermittent observation of the Engineer to confirm that subsurface conditions are as expected. The Contractor shall keep records of the excavation depth, drilling rates and the transition depth from soil to rock for each drilled excavation.

If excessive sloughing or collapse of the drilled excavation is occurring, then the holes shall be cased to prevent caving. The casing shall be withdrawn as grout is placed.

3.06 Steel Placement - Install the steel thread bars and centralizers promptly after drilling. Centralizers shall be placed every 5 feet along the soil nail to maintain the steel in the middle of the hole.

3.07 Grout Placement - Immediately after the installation of the steel, grout shall be pumped through a grout pipe or tube extending to the bottom of the drilled excavation. The grouting operation shall be a continuous with the grout pipe kept well below the top of the grout at all times. An accurate record of the amount of grout placed in each excavation shall be maintained by the Contractor.

3.08 Verification and Proof Testing - Soil nails shall be load tested to verify that they will resist the design load. Perform a minimum of one verification tests in each row of nails as highlighted on the project plans. Verification tests nails will be sacrificial. Perform proof testing on a minimum of 5% of the production nails in each row or a minimum of 1 per row, as shown on the plans or as designated by the Engineer.

The Contractor shall provide the test set up, hydraulic jack and pump, gages, other equipment, and labor to perform and record the proof testing under the technical direction of the Engineer. Testing will be carried out no sooner than when 80% percent of the grout design strength is achieved.

Load tests shall be made by incrementally loading the soil nail. The loads shall be applied with a hydraulic jack equipped with a pressure gage that has been calibrated within the prior 6 months as evidenced by a written certificate. The hydraulic pump shall be capable of applying each load increment within 60 seconds and maintaining the load increment within 5 percent of the intended load during the test period.

The soil nail displacement shall be measured with a dial gauge or other target capable of accurately measuring to 0.001 inches.

The verification load test sequence shall be as follows. Except for the reading of the residual movement at AL, no movement readings need to be taken during unloading of the anchor.

Verification Load Testing Schedule (Ratio of Design Load – DL)

AL (.05 DL), 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL (CTL), 1.75 DL, 2.00 DL

The alignment load (AL) should be applied and held until no displacement occurs. Dial gauges should be set to “zero” after application of the alignment load. The load at each increment thereafter shall be held for a minimum of 10 minutes or until displacement ceases. The final displacement shall be recorded at each load interval. The creep test load (CTL = 1.50 DL) shall be held for a minimum of 60 minutes, displacement measurements shall be taken at 1, 2, 3, 4, 5, 6, 10, 20, 30, 45 and 60 minutes. The total movement within the period of 6 to 60 minutes shall not exceed 0.080 inches (2mm).

Proof Load Testing Schedule (Ratio of Design Load – DL)

AL (.05 DL), 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.33 DL (CTL)

The alignment load (AL) should be applied and held until no displacement occurs. Dial gauges should be set to “zero” after application of the alignment load. The load at each increment thereafter shall be held for a minimum of 1 minute or until displacement ceases. The final displacement shall be recorded at each load interval. The creep test load (CTL = 1.33 DL) shall be held for 10 minutes, displacement measurements shall be taken at 1, 2, 3, 4, 5, 6, and 10 minutes. If the total movement between 1 minute and 10 minutes exceeds 0.04 in. (1mm), the test load shall be held for an additional 50 minutes with further displacement measurements made at 15, 20, 25, 30, 45, and 60 minutes. The total movement within the period of 6 to 60 minutes shall not exceed 0.080 in. (2mm).

- 3.09 Test Nail Acceptance or Rejection – A test nail shall be considered acceptable when it does not pull-out and meets the testing and allowable displacement criteria described

above. If a test nail does not meet the accepted criteria, the Contractor shall determine the cause of failure.

For a test nail that does not meet acceptance criteria, the Engineer shall review the results of each verification test. Installation methods which do not satisfy the testing requirements shall be rejected. The Contractor shall propose alternative methods and install replacement verification nails at no additional costs.

The Engineer may require replacement of some or all of the production nails between a failed proof test and adjacent passing proof test nail. Engineering may require installation and testing of additional proof nails to verify adjacent production nails have sufficient load carrying capacity. Production nails may be assigned a reduce capacity and additional production nails may be required to achieve the specified design loads. Installation and testing of additional proof test nails or additional production nails due to proof test nail failures shall be at no additional cost to Owner.

END OF SECTION

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SECTION 02390 - SHORING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Work specified in this Section includes shoring systems for the support of excavations including, but not limited to, trench and structure excavations. The Contractor shall furnish, install, and remove upon completion of the required construction, unless shown otherwise, all systems of supports, including all bracing and associated items to retain the sides of the excavations. The Contractor shall be responsible for the selection of methods, the design, construction and removal of all shoring systems. Shoring shall be required unless otherwise approved by the Engineer. Shoring systems shall be integrated with Section 02200 – Earthwork.
- B. The provisions specified hereunder shall be understood:
 - 1. To complement, and not to substitute or diminish, the obligations of the Contractor for the furnishing of a safe place of work pursuant to the provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for the protection of the Work, structures, and other improvements.
 - 2. To represent a minimum requirement for:
 - a. The number and types of means needed to maintain soil stability.
 - b. The strength of such required means.
 - c. The methods and frequency of maintenance and observation of the means used for maintaining soil stability.
- C. Excavation support shall include sheeting, shoring, bracing, and other means and procedures required to maintain the stability of soils in the excavations.
- D. The Contractor shall provide excavation support in trenches for the protection of workers from the hazard of caving ground. Excavation supports shall be provided:
 - 1. Where soils are estimated to be unstable due to excavation work and an analysis performed pursuant to general engineering design practice.
 - 2. The excavated face or surrounding soil mass may be subject to slides, caving, or other type of failure.
 - 3. The stability and integrity of existing structures and other improvements may be compromised by settlement or shifting of soils.
- E. Whatever dewatering system is used, the shoring and dewatering system should together meet all of the following minimum requirements:
 - 1. Provide stable excavation walls and bottom.
 - 2. Provide reasonably dry base of excavation.
 - 3. Filter native soil and prevent loss of ground through piping.
 - 4. Prevent hydrostatic uplift pressure during construction.

5. Where shoring is not designed to resist hydrostatic pressures, draw down the groundwater level below and beyond the excavation sidewalls.
6. Protect adjacent existing utilities, pipelines, and structures.
7. Installation of support system should not cause settlement or heave of the ground surface nor produce construction vibrations that could damage adjacent utilities or structures.
8. Prevent running, caving and sloughing of excavation walls and associated loss of adjacent utilities or structures.
9. Resist lateral earth pressures, hydrostatic pressures lateral loads from traffic, construction equipment, and spoils.
10. Allow for the removal of shoring in a manner that does not damage structures (new and existing), adjacent utilities, and the pipeline and does not cause settlement or heave of the structure pipeline or settlement or heave of the ground surface, not produce construction vibrations that could damage adjacent utilities, pipelines, or structures.

F. The Contractor's dewatering and shoring submittal should contain alternative (i.e., contingent) systems, and the Contractor should be prepared to alter initial dewatering systems and/or implement alternative dewatering and shoring systems should the initial systems not achieve the above minimum requirements.

G. Where shoring is not designed to resist hydrostatic pressures, the dewatering systems need to be designed to draw down the groundwater level below the excavation bottom and below and beyond the excavation sidewalls. Piezometers (i.e., monitoring wells) should be installed adjacent to the excavation to monitor the groundwater levels prior to and while the excavation is open. The purpose of the piezometers is to confirm that the groundwater level is adequately lowered prior to and during excavation and shoring installation.

H. Groundwater dewatering wells, well points, and piezometers should be installed and removed in accordance with local requirements and regulations.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the requirements of applicable codes and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided latest edition of the code, as adopted as of the date of award by the agency having jurisdiction, shall apply to the Work.

B. Reference codes, regulations, specifications and standards include, but are not limited to:

1. California Labor Code
2. Occupational Safety and Health Administrative Code
3. Manual of Steel Construction, AISC, 9th Edition

- C. The Contractor's attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The Contractor, prior to beginning any trench excavation exceeding 5 feet in depth, shall submit to the Engineer and shall be in receipt of the Engineer's written acceptance of the Contractor's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation. Plans shall be prepared and sealed by a Civil or Structural Engineer registered in the State of California.
- D. It is important that the Contractor review and become familiar with the geotechnical report prepared for this project by. In particular, the Contractor must be aware of the following subsurface conditions which will affect shoring, as well as dewatering:
 - 1. Excavations that extend below the groundwater will require dewatering. Refer to Section 02140 – Dewatering.

1.3 DESIGN CRITERIA

- A. General. In all areas, the shoring system, including all the components, shall be designed by the Contractor to support earth and rock pressure, unrelieved hydrostatic pressures, utility loads, equipment, applicable traffic and construction loads, and other surcharge loads in such manner as will allow the safe and expeditious construction of the permanent structures without movement or settlement of the ground and will prevent damage to or movement of adjacent structures and utilities.
- B. It is the Contractor's responsibility to review the existing underground utilities, to make his/her own interpretation regarding the ground conditions from previous reports and borings, and to make any other additional surveys and/or borings he/she believes are necessary to determine the types and extent of bracing and shoring systems required to accomplish the Work. All of the foregoing costs shall be included in the Contractor's total price for performing the Work.
- C. Sloped excavations shall not be permitted unless otherwise approved by the Engineer.

1.4 SUBMITTALS

- A. Shop Drawings. The Contractor shall submit shop drawings and supporting calculations of excavation support systems shall be submitted in accordance with the requirements of Section 01300 - Submittals. The shop drawings shall be prepared and sealed by a Civil or Structural Engineer registered in the State of California.
- B. All expenses incurred in performing the Work described in this Section shall be borne by the Contractor.

1.5 RELATED REPORTS

- A. A Geotechnical Report has been prepared for this project. The report is entitled Geotechnical Investigation, Treatment Plant Upgrade Project, Sausalito-Marín City Sanitary District, Sausalito, California, Miller Pacific Engineering Group, March 2014.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All timber and structural steel used for the supporting system, whether new or used, shall be sound and free from defects that may impair their strength.
- B. Sheet piling shall be of an internally braced continuous interlocking type forming a continuous wall. Sheet piling and all accessories shall conform to the requirements of ASTM A328.
- C. Structural steel members shall be designed in accordance with the Manual of Steel Construction. Timber members shall be designed in accordance with the latest edition of the Uniform Building Code.

2.2 PERMANENT SHEET PILE RETAINING WALLS

- A. For permanent sheet pile retaining walls, all materials must be new, free from defects, and shall be of the best commercial quality for the purpose specified.

PART 3 EXECUTION

3.1 STEEL SHEET PILING

- A. The Contractor shall drive sheet piling in plumb position with each pile interlocked with adjoining piles for its entire length including corners so as to form a continuous diaphragm throughout the length of each run of wall and at each wall corner, bearing tightly against original ground.
- B. The sheet piling shall be driven to the depth indicated on the shop drawings, with a minimum depth of 5 feet below the bottom of the trench, or the excavation bottom.
- C. The Contractor shall exercise care in driving to avoid damage to existing utilities so that interlocking members can be subsequently extracted without injury to adjacent fills or existing utilities.

3.2 INTERNAL BRACING SUPPORT SYSTEM

- A. The Contractor shall provide internal bracing support system including lagging and sheeting, sheet piles, wales, struts, and/or shores.
- B. The Contractor shall install and maintain all bracing support members in tight contact with each other and with the surface being supported. Support system monitoring provisions shall be installed as indicated on the shop drawings.
- C. If necessary to control shoring movement, the Contractor shall preload bracing members by jacking struts to 50 percent of the design load. Preload bracing members shall be loaded in accordance with methods, procedures, and sequence as described on the approved shop drawings. Excavation work shall be coordinated with the installation of bracing and preloading. Steel shims and steel wedges welded or bolted in place to maintain the preloading force shall be used in the bracing after release of the jacking equipment pressure.

- D. Excavation shall proceed to no more than two feet below point of the support about to be placed. The support shall be installed and preloaded immediately after installation and prior to continuing excavation.

3.3 REMOVAL OF SUPPORTING SYSTEM

- A. The Contractor shall remove all shoring, including sheet piles, wales, struts, lagging and shores from the excavation, unless shown otherwise. Removal of the supporting system shall be performed in a manner that will avoid damage of adjacent construction or facilities. All voids created by the removal of the supporting system shall be immediately filled with well-graded cohesionless sand, lean concrete, or sand cement grout.

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SECTION 02460 – ASPHALT CONCRETE PAVEMENT AND BASE

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform all work associated with Asphalt Concrete (A.C.) Pavement and Base as shown and as specified herein including all labor, materials, equipment supplies, and facilities associated with providing a finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
State of California Department of Transportation (CalTrans) Standard Specifications	

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall submit, in writing, materials testing reports, job-mix formulas and other pertinent information satisfactory to the Engineer demonstrating that materials and methods Contractor proposes to utilize will comply with the provisions of this Section. Submittals shall be in accordance with Section 01300 Submittals.
- B. Suitability Tests of Proposed Materials: Tests for conformance with the Specifications shall be performed prior to start of the Work. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the Work where the material represented by the sample is to be used. Results of all tests shall be submitted to the Engineer for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.
- C. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be borne by the Owner but the Contractor shall furnish the materials at no cost. Any additional trial batch testing required shall be performed at the expense of the Contractor.

PART 2 PRODUCTS

2.1 AGGREGATE BASE

- A. Materials for aggregate base shall be Class 2 Aggregate Base as specified in Section 02200 – Earthwork.

2.2 PRIME COAT

- A. Prime coat shall be Grade SS-1H emulsified asphalt complying with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397).

2.3 TACK COAT

- A. Tack coat shall be emulsified asphalt Grade SS-1 or, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.4 ASPHALT CEMENT

- A. Asphalt Cement shall be Grade PG 64-10 complying with the requirements of AASHTO M226 (ASTM D 3381).

2.5 MINERAL AGGREGATE

- A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials.

Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

- B. Mineral filler shall comply with ASTM D 242.
- C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.6 ASPHALT-AGGREGATE MIXTURE

- A. Base and Surface Course Mixture: The Contractor shall submit for approval a job-mix formula for each mixture. The job-mix formula for the asphalt-aggregate base and surface course mixture shall conform to the requirements of the Caltrans Standard Specifications, Section 39, for Type B asphalt concrete, 19 mm ($\frac{3}{4}$ inches) medium.

2.7 SLURRY SEAL

- A. Asphalt emulsion shall be Grade SS-1 or SS-1h, or Grade CSS-1 or CSS-1h complying with the requirements of AASHTO M 140 (ASTM D 977). Aggregate shall consist of rock dust and plaster sand or other sands of similar nature, except that an aggregate or combination of aggregates shall contain not less than 50 percent of the product obtained by crushing rock. The material shall be free from vegetable matter and other deleterious substances. Asphalt emulsion shall be added at a rate of from 11 to 25 percent weight of the dry aggregate. The Contractor shall submit the asphalt emulsion addition rate for Engineer review and acceptance.

2.8 CRACK SEALER

- A. The crack sealer shall be a mixture of paving asphalt and ground rubber or ground rubber and polymer which conforms to the following requirements:

Test	Test Method	Specification
Softening Point	ASTM D-36	180°F minimum
Cone Penetration at 77°F	ASTM D-3407	30 minimum 90 maximum
Resilience at 77°F	ASTM D-3407	40% minimum
Flow @ 140°F	ASTM D-3407	3 mm maximum

- B. The gradation of the ground material shall be such that 100% will pass the #8 sieve. The modified asphalt material shall be furnished premixed in containers with an inside liner of polyethylene. Packaged material shall not exceed 60 lbs. in weight. Storage and heating instructions and cautions shall be supplied by the vendor with each shipment.
- C. The materials shall be capable of being melted and applied to cracks and joints at temperatures below 400°F. When heated, it shall readily penetrate cracks $\frac{1}{4}$ -inch wide or larger.
- D. A Certificate of Compliance conforming to the above requirements shall be supplied with each shipment.

2.9 SOIL STERILANT

- A. Soil sterilant or chemical weed control agent shall be a commercial product manufactured specifically to sterilize the subgrade soil to prevent the growth of weeds, plants or any type of vegetation.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

- A. The subgrade shall be prepared as specified in the Section 02200 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the specified grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section. Apply soil sterilant or chemical weed control agent in strict compliance with manufacturer's dosages and application instructions, and any applicable laws, ordinances or regulations governing the use of such chemicals.

3.2 AGGREGATE BASE

- A. Aggregate base shall be provided where shown and to the thickness shown. Imported aggregate bases shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches the base material shall be spread and compacted in two or more layers of approximately equal thickness and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

3.3 PRIME COAT

- A. Prior to placing of pavement a prime coat of emulsified asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

3.4 TACK COAT

- A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.5 ASPHALT CONCRETE

- A. At the time of delivery to the Work site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.
- B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.
- C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the specified cross section and grade of the course being constructed.
- D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical the Engineer may waive the self-propelled requirement.
- E. Spreading, once commenced, must be continued without interruption.
- F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.
- G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.
- H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.6 GROOVING AND GRINDING

- A. Pavement shall be grooved or grinded as shown on the Contract drawings for repaving.
- B. Grooving and grinding shall conform to the requirements of the Caltrans Standard Specifications, Section 42.

3.7 CRACK SEALING

- A. Crack sealing shall not proceed until all other preparation operations are completed and approval to proceed with crack sealing is granted by the Engineer. Such other preparation operations shall include, but not be limited to, asphalt base repairs and pavement milling.

- B. Crack sealing work shall be completed as specified herein prior to application of any finish surface treatments. Such treatments may include, but not be limited to, asphalt concrete leveling course, asphalt concrete overlay, and slurry seal.
- C. Cracks narrower than ¼" need not be filled. Cracks wider than ¼ inch shall be routed to create a uniform width of rectangular cross section. Routed crack width shall be slightly greater than the widest point of the existing crack, and slightly deeper than its deepest depth in order to achieve a uniform rectangular width and depth. Rounded bottoms and V-shaped routs create conditions for sealant debonding and will not be permitted.
- D. After routing is performed, routed crack shall be blown clean of loose materials with a high pressure air nozzle, (90 psi or greater) to the satisfaction of the Engineer. Loose materials include vegetation, dust, dirt, moisture, old sealant, and foreign material. The contractor shall use duct tape to check the cleanliness of the newly routed crack in the presence of the inspector. A few feet of the sticky surface of the duct tape shall be pressed into the rout and pulled out. After proper cleaning, there shall be very little, if any, residue or debris on the tape.
- E. Equipment used by the Contractor shall be specifically built for this purpose and shall be of current manufacture (Crafco Model BC-220 or an approved equal).
- F. In order to reduce sealant degradation, sealant shall be heated to the lowest temperature recommended by the material supplier or as approved by the Engineer. The material shall be held in the mixing tank at application temperature until very little separation of the rubber and asphalt occurs when a bead of sealant material is placed on the pavement. Sealant material may be added to the mix as long as the minimum temperature is maintained. Only enough sealant that is needed to complete the work on a given day shall be heated. Sealant shall not be re-heated if allowed to cool. Heating of sealant overnight for use the following morning shall not be permitted.
- G. Cracks shall be sealed from the bottom up. Sealant material shall be applied so it is flush with the pavement surface. Sealant material must not be higher than the adjacent surface. Crack sealant fill material shall be placed no later than noon each day so that hot afternoon pavement temperature and associated pavement expansion does not excessively shrink the true size of each crack.
- H. Traffic shall not be allowed on the material until it has cured or until it has been sanded to prevent tracking and damage to vehicles. Pavement and reinforcing fabric shall not be placed for at least 24 hours after crack sealing.

END OF SECTION

SECTION 02500 – BURIED PIPE INSTALLATION

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install all buried yard piping and related appurtenances including connections to existing and new structures in accordance with the requirements of the Contract Documents.
- B. Work specified under this section shall also conform to pipe material specifications found in Division 2 – Sitework and Division 15 – Mechanical.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

Commercial Standards:

Pacific Gas & Electric Co. Gas Applicant Design Manual for Residential and Commercial Applications

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The CONTRACTOR shall submit shop drawings and laying diagrams of pipe and fittings in accordance with the requirements of Section 01300 - Submittals, and the following supplemental requirements as applicable:
 - 1. For all pipes 24-inch and larger, and all pipe using non-standard fittings, line layout and marking diagrams shall be provided. The line layout and marking diagrams shall include the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layout shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; the limits of each reach of restrained and/or welded joints; and the limits of concrete encasement.
 - 2. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of any pipe lining.
 - 3. A hydrostatic test plan demonstrating compliance with Section 02640 – Pipeline Testing and Disinfection.
 - 4. Details and locations of closures for length adjustment and for construction convenience.
 - 5. Detail drawings indicating the type, number and other pertinent details of the slings, strutting and other methods proposed for pipe handling during manufacturing, transport and installation.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipe Material Options

1. The pipe schedule, located in the Drawings, defines the allowable options for pipe material, based on fluid type.
2. Pipe material designations and transitions on the Drawings shall take precedence over the options presented in the pipe schedule.
3. Depending on the pipe material selected by the CONTRACTOR, the applicable details for corrosion protection and thrust restraint shall apply.
4. Transition from mortar lined and mortar coated steel pipe shall be composed of a flanged end on the steel pipe and a flange-coupling adaptor or flexible coupling on the non-steel pipe, as appropriate.

B. Corrosion Control: All required corrosion control measures shall be provided, installed and tested in accordance with the Pipe Schedule, Section 13115 – Cathodic Protection Systems, Section 09960 – Protective Coatings, and all other applicable drawings, details and specifications.

C. Marking: The CONTRACTOR shall legibly mark all shop-fabricated specials 24 inches in diameter and larger and all mitered pipe in accordance with the laying schedule and marking diagram. Each marked element shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. A mark indicating the true vertical axis of each marked pipe, special and fitting shall be placed on the top and bottom of the pipe, special or fitting.

D. Pipe identification

1. Detection Wire: Detection wire shall be a single strand No. 10 A.W.G. insulated copper wire laid along the top of all plastic and reinforced concrete pipe and held in place with ties or hitches of the same kind of wire spaced not more than 13 feet apart.
2. Detection wire shall be terminated at structure connections.

E. Pipe Testing: Pipe material testing shall be in accordance with the pipe material specifications and the applicable Commercial Standards. Pipe functional and performance testing shall be in conformance with Section 02640 – Pipeline Testing and Disinfection.

F. Pipe material changes shall be as indicated in the Contract Drawings and in the Process Fluid Schedule.

G. Bolts and Hardware: Bolts and hardware, including nuts, washers, restraining rods for pipe and appurtenances shall meet the requirements of Section 15000 – Piping, General. ENGINEER Pipe Encasement: Concrete encasement of pipes shall utilize the reinforcing steel in the sizes and arrangements as shown in the General Civil Details and as specified in Section 03200 – Concrete Reinforcement. Concrete for encasement shall be as specified in Section 03300 – Cast-In-Place Concrete.

- H. Process Fluid Schedule: The process fluid schedule is included in the Pipe Schedule. Material types shall be as designated in the Process Fluid Schedule unless otherwise noted in the Contract Drawings. Physical locations of pipe material changes are indicated on the Contract Drawings by the symbol defined in the Process Fluid Schedule.
- I. Insulation Flanges: Insulation flanges shall be provided on all metallic pipes at the buried pipe-exposed pipe transition. Additional requirements can be found in Section 13115 – Cathodic Protection Systems.
- J. Trench Dams, Plugs: Trench dams and plugs shall be installed where indicated on the Contract Drawings and shall conform with the material requirements of Section 02200 – Earthwork and the General Civil Details.
- K. Protective Coating: As required in individual pipe specs and as called for in Section 09960 – Protective Coatings.
- L. Utility Supports: All existing utilities that are encountered during the work shall be supported as shown in the General Civil Details or as otherwise specified in the Contract Documents.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All pipe, specials and fittings shall be handled, at a minimum, at the 1/3 points by use of wide fabric slings, padded cradles, or other devices acceptable to the ENGINEER, which are designed and constructed to prevent damage to the pipe coating. The use any equipment which might injure any pipe coating will not be permitted. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All other pipe handling equipment and methods shall be acceptable to the ENGINEER.
- B. Handling and Storage: All pipe and fittings shall be carefully handled and protected against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed when the lining or coating/interior or exterior surfaces show cracks that may be harmful as determined by the ENGINEER. Such damaged lining and coating/interior and exterior surfaces, shall be repaired or a new undamaged pipe shall be provided.
- C. Fittings shall be lowered into trench carefully and without damage to the fittings. Any device used for lowering fitting into trench shall be attached around the exterior of the fitting for handling. Under no circumstances, shall any device be attached through the fitting's interior for handling.
- D. All damaged pipe shall be repaired or replaced by the CONTRACTOR.
- E. The CONTRACTOR shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The CONTRACTOR shall remove or smooth out any fins, burrs, gouges, weld splatter, or other small defects prior to laying the pipe.

- F. Store all pipe materials in accordance with pipe manufacturer's recommendations and the following requirements until installation.
 - 1. Keep pipe at ambient outdoor temperature.
 - 2. Provide temporary shading for plastic pipe.
 - 3. Any covering practices that will cause a temperature build-up are not acceptable.

3.2 INSTALLATION OF PIPE AND APPURTENANCES

A. General

- 1. Piping and its installation shall be in accordance with Section 02200 – Earthwork, Section 02140 – Dewatering and Section 15000 – Piping, General and the following general requirements.
- 2. The CONTRACTOR shall provide all fittings, closure pieces, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as required to provide a complete and workable installation.
- 3. The CONTRACTOR shall provide support and protection for all crossing utilities exposed during construction.
- 4. The CONTRACTOR shall verify the type, size and condition of existing pipe prior to installing the new pipe. The pipe shall be inspected for corrosion of other conditions that would prevent an adequate connection. If dewatering of an existing line is required, a minimum of 14 days notice shall be given to the Owner to allow for adequate time to prepare the line for the connection. Connections to dewatered lines shall be expedited to minimize service interruptions.
- 5. Locations of existing pipes are approximate. CONTRACTOR shall field verify connection locations prior to starting work or detailing shop drawings.
- 6. All pipes entering or leaving structures, except air, gas and solvent welded plastic pipe, shall be provided with a minimum of two flexible pipe segments. Differential settlement of up to two inches is anticipated for newly constructed structures, pipe transitions into and out of each new structure shall be laid out to accommodate this level of differential settlement as well.

B. Layout and Grade

- 1. Pipe Laying: Unless otherwise required, all pipe shall be laid straight between the changes in alignment and at uniform grade between changes in grade. Pipe utilizing bell-and-spigot joints shall be laid with the bell end pointing in the direction of laying. Pipe shall not be laid when the conditions of trench or weather are unsuitable.
- 2. The CONTRACTOR shall not use the pipeline as a conductor for trench drainage.
- 3. Installation Tolerances: Where provisions of these Specifications require pipe laying diagrams, the pipe shall be laid in the order and position shown on the laying diagram and in accordance with the following:

- a. Each section of pipe having a nominal diameter less than 48 inches shall be laid to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1-inch vertical deviation.
 - b. Each section of pipe having nominal diameter 48 inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
 - c. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.
 - d. On grades of zero slope, the intent is to lay the pipe as close as possible to level.
4. Trench excavation, bedding, and backfill shall be in accordance with Section 02200 – Earthwork. Trenches shall be graded to provide a uniform and continuous support beneath the pipe at all points to prevent point loading at any location along the pipe section.
5. Trenches shall be in a reasonably dry condition when the pipe is laid. Necessary facilities including slings shall be provided for lowering and properly placing the pipe sections in the trench without damage. The pipe and specials shall be laid to the line and grade indicated and shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding shall be checked for firmness and uniformity of surface.
6. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
7. Driving pipe down to required grade by striking with shovel handle, timber, or other object is prohibited.
8. Large yard pipe, 12-inches in diameter or greater, shall be installed at the coordinates identified in the Contract Documents.
9. Small yard pipe, less than 12-inches in diameter, are shown in approximate locations in the Contract Documents and shall be installed by scaling their location from the Drawings.
10. Pipe shall be installed in accordance with the applicable reference standards and the supplemental requirements specified herein.
11. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75% of the maximum deflection recommended by the pipe manufacturer. No joint

shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.

12. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers or main drains, the construction shall be permanently supported, relocated, removed or reconstructed by the CONTRACTOR in cooperation with owners of such utility structures. Unless otherwise indicated and where utilities are shown in the Contract Drawings, this work shall be performed at the CONTRACTOR's expense.
13. Except for short runs which may be permitted by the ENGINEER, pipes shall be laid uphill on grades that exceed 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed.
14. The CONTRACTOR shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, shall assume full responsibility for any damage due to this cause, and shall at its own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floatation.
15. All drainage or gravity flow pipe shall maintain an average slope between elevations as indicated on the drawings, as described in this Section, to clear any interference. In no case shall the pipe slope be less than 0.2 percent unless noted otherwise.
16. All pressure (non-gravity) pipe shall be installed with a slope to allow free drainage to blow-off valves or structures. Elevations indicated on the drawings are maximum and can be lowered to accommodate interferences provided free drainage can be maintained.
17. Slope of pressure pipe between structures, when no intermediate blow-offs are shown, can be adjusted, provided adequate adjustment exists inside structures to provide free drainage.
18. All pipe shall have a minimum cover greater than 2'-6" unless noted otherwise.
19. Where minimum cover cannot be maintained, the pipe shall be concrete encased per General Civil Details. In no case shall the concrete encasement be exposed above the ground or take the place of minimum asphalt paving thickness.
20. Pipe, shown concrete encased under structures, shall be concrete encased to a minimum distance beyond the structure equal to the footing clearance.
21. No pipe shall be installed so that it is under tension. Make allowance for thermal expansion/contraction when installing pipe, particularly plastic pipe, in warm temperatures; otherwise the pipe will be in tension when it cools. Flexible plastic pipe can be "snaked" in the trench to prevent cooling into tension.

C. Support

1. Thrust restraint shall be provided where indicated and joints shall be provided as indicated or otherwise noted in the Contract Documents.

2. Anchors and supports shall be provided where necessary and where indicated on the drawings for fastening work into place. Fittings shall be independently supported.

D. Handling

1. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
2. Proper implements, tools and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contactor for safe and efficient execution of the work.

E. Cleaning

1. Pipe and Specials Protection: The openings of all pipe and specials where the pipe and specials have been mortar lined in the shop shall be protected with suitable bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water, or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe.
2. Before placement of pipe in a trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, at all times when the work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals, water and foreign material. The use of burlap, wood or other similar temporary plugs will not be permitted.
3. If water is in the trench, do not remove trench closure devices until provisions are made to prevent water, earth or other substances/material from entering the pipe.
4. Pipe Cleanup: As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of all debris. The CONTRACTOR shall completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints as applicable, and any necessary interior repairs prior to testing and disinfecting the completed pipeline. The CONTRACTOR shall maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until acceptance by the Owner.
5. Never weld close to plastic pipe without protecting the pipe with a heat-resistant baffle or a wet rag. Perform welding on pipe connected and immediately adjacent to plastic pipe to minimize the possibility of directing sparks or hot material into the plastic from inside the pipe.

F. Installation of Pipeline Appurtenances:

1. Unless noted otherwise, buried appurtenance shall be coated with the same material and thickness as the adjoining pipe.

2. All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. The CONTRACTOR shall adjust all stem packing and operate each valve prior to installation to insure proper operation. All valves shall be installed so that the valve stems are plumb and in the location shown.
3. All buried valves, flanges, couplings and other appurtenances shall be coated and protected in accordance with Section 09960 - Protective Coatings.
4. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved, and calibrated torque wrench. All clamping torque shall be applied to the nuts only. Full face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.
5. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets, and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer.
6. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable, approved, and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.
7. All fittings and appurtenances shall be installed utilizing standard installation procedures. Fittings and appurtenances shall be carefully connected to pipe or other facility, and joint shall be checked to ensure a sound and proper joint.

G. Thrust Restraint

1. Thrust restraint for yard piping shall be as indicated on the Contract Drawings and in the Civil Details. Thrust restraint requirements for each pipe material type are as indicated in the pipe material schedule. For restrained joint options, a minimum of one joint upstream and one joint downstream of a bend of 22.5 degrees or greater shall be restrained on otherwise unrestrained joint pipe.
2. Where allowed by the pipe material schedule and where used, mechanical restraints shall be Megalug brand, manufactured by EBAA Iron, Inc. The mechanical restraints shall be installed according to the Contract Drawing details.
3. For any joint whose size and test pressure combination is not specifically identified in the Contract Documents, the CONTRACTOR shall submit thrust restraint calculations to the ENGINEER for approval prior to the fabrication and installation of the restrained joint.
4. Welded (heat or solvent) pipe, fused pipe or pipe with threaded joints shall not require the installation of additional thrust restraint.

5. Pipes with any form of push-on or compression joint shall require additional thrust restraint according to the Civil Details.

3.3 CORROSION CONTROL

- A. Electrical Continuity: Except where otherwise specified, all non-welded joints on metallic (steel, ductile iron, alloy) pipe shall be bonded in accordance with the details shown. The pipe shall be cleaned to bare bright metal at the point where the bond is installed and the bond wire installed utilizing procedures in accordance with the requirements of Section 13115 – Cathodic Protection System, and as shown in the Drawings.
- B. Electrical Insulation: All buried metallic pipelines shall be electrically isolated from above-grade structures and at all terminations utilizing insulating flanges in accordance with the requirements of Section 13115 – Cathodic Protection System, and as shown in the Drawings. In addition, all pipes shall be electrically isolated from reinforcing bars as building/structure penetrations.
- C. Cathodic Protection: All buried piping shall be provided with corrosion monitoring and test stations in accordance with the requirements of Section 13115 – Cathodic Protection System, and as shown in the Drawings.
 1. Buried ductile iron or steel pipe shall be installed with test stations in accordance with the requirements of Section 13115 – Cathodic Protection System and as shown in the Drawings.
 2. Poly vinyl chloride (PVC) pipe (with ductile iron fittings) shall be installed with test stations at each ductile iron fitting in accordance with the requirements of Section 13115 – Cathodic Protection System, and as shown in the Drawings.

3.4 TESTING AND DISINFECTION

- A. All completed pipelines shall be tested and disinfected in accordance with Section 02640 – Water Pipeline Testing and Disinfection.

END OF SECTION

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SECTION 02510 – FRP DUCTWORK

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals required to install foul air ductwork for the control of atmospheric H₂S and other noxious odors as shown on the drawings and specified herein.
- B. The odor control systems shall consist of the following major components:
 - 1. FRP foul air ductwork and dampers
- C. Related work described elsewhere:
 - 1. Division 1 – General Requirements
 - 2. Section 15006 – Pipe Supports

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All codes, as referenced herein, are specified in the section entitled “Reference Standards”.
- B. Commercial Standards
 - 1. ASTM C 582 – Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
 - 2. ASTM D 2310 – “Standard Classification for Machine-Made “Fiberglass” Pipe.
 - 3. ASTM D 2992 – “Standard Practice for Obtaining Hydrostatic Design Basis for Fiberglass Pipe and Fittings.
 - 4. ASTM D 3567 – Practice for Determining Dimensions of “Fiberglass” Glass Fiber Reinforced Thermosetting-Resin) Pipe and Fittings
 - 5. ASTM D 3982 – Standard Specification for Contact-Molded “Fiberglass Duct and Hoods” or NBS PS 15-69 “Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.
 - 6. AWWA M-45 – American Water Works Manual of Water Supply Practices “Fiberglass Pipe Design”

1.3 SYSTEM DESCRIPTION

- A. The foul air ductwork and shall be installed as generally shown on the Drawings. This arrangement is intended to represent the minimum standard of quality and treatment capacity.

1.4 CONTRACTOR SUBMITTALS

- A. Shop Drawings shall be in accordance with Section 01300 – Submittals. Shop drawings for the foul air ductwork shall include:
 - 1. FRP ductwork, fittings, dampers, and specials.

PART 2 PRODUCTS

2.1 FRP DUCTWORK

- A. Foul air ductwork shall be fiberglass reinforced plastic (FRP) designed for 15 inches water column pressure, and 6 inches water column vacuum. Buried ductwork shall also be designed for H2O traffic loading with 1 percent maximum deflection. Exposed ductwork shall have an ultraviolet stabilizer as recommended by the resin manufacturer.
- B. FRP fittings shall be contact molded. Joints shall be flanged or butt and strap joints. Flexible connections shall be provided at blowers. All hardware and fasteners shall be Type 316 stainless steel.
- C. FRP ductwork and fittings shall be designed and fabricated for odor control service to carry warm, moisture-laden air containing hydrogen sulfide, mercaptans and other organic and inorganic compounds typically associated with wastewater facilities.
- D. Ductwork installed above grade shall be supported for gravity loads, thrust loads and seismic and wind loads in accordance with Section 15006 – Pipe Supports.
- E. Minimum Corrosion Liner:
 - 1. 1 "C" or Nexus veil as specified for the service environment.
 - 2. Remainder 1-1/2 ounce per square foot mat to total minimum thickness of 0.096 inches on surface exposed to the service environment.
- F. Ultra Violet Stabilizer: Add to the exterior surface resin coat of fabrications intended for outside service, in the type and amount recommended by the resin manufacturer.
- G. Resin: Add fire retardant premium vinyl ester as follows:
 - 1. Ashland, Hetron 992FR.
 - 2. Reichhold Dion, VER 9300FR.
- H. Resin for Structural Layers: Resin with sufficient antimony trioxide or pentoxide for Class I fire rating.
- I. Color: Add pigment to the exterior surface resin coat such that the color of the duct will be similar to paint used for equipment, except that ducting for air conditioning systems which are concealed above suspended ceilings need not be pigmented. Color selected by Owner.
- J. Where indicated on the Contract Drawings, ductwork shall be provided with taps for insertion airflow probes, and bosses for mounting gas sensors. Taps and bosses shall be sized in accordance with manufacturers' recommendations. Blind flanges and airtight gaskets shall be provided for all taps for when the airflow probes are not being used.

- K. Provide fasteners, field joints, expansion joints, flexible couplings, and supports required for complete installation of a duct system. All hardware shall be of Type 316 stainless steel.
- L. Fiberglass Reinforced Plastic Ductwork: One of the following or equal:
 - 1. Century Fiberglass, Inc., Anaheim, CA.
 - 2. LaValley Construction, Biloxi, MS.
 - 3. Paramount Plastics, Rancho Cucamonga, CA.
 - 4. Ross Industries, Inc., Orange, CA.

2.2 FRP DAMPERS

- A. FRP dampers shall have flanged connections to round ducting, with vinyl ester resin fiberglass construction conforming to ASME RTP1 with 30 mil resin rich interior corrosion layer, and flanges integral to the web layup. The blades shall be provided with Viton elastomer edge seal, and the blade axle shall be a vinyl ester resin fiberglass rods with PTFE bearings and axle shaft seal. Metal components shall be Type 316 stainless steel.
- B. FRP dampers and backdraft dampers shall be as manufactured by Belco Manufacturing Model 202, Swartwout Model 912, or approved equal.

2.3 EXPANSION JOINTS

- A. Single sphere molded non-metallic expansion joints shall be provided and installed on each blower suction and discharge pipeline and where indicated on the Drawings. Expansion joints shall be Proco Products Series 240 molded expansion joints, American Seal & Packing expansion joints, or approved equal.

2.4 FLEXIBLE CONNECTIONS

- A. Flexible connections shall be provided of sufficient length to allow connections from the rigid FRP ducts to moveable bins. Flexible connections designed for the intended use and shall be manufactured of a light weight, UV resistant material. Flexible connections shall be of the same diameter as the connecting rigid FRP duct.
- B. Where used on sludge storage bins or dumpsters, flexible ducts shall be fitted with easy to disconnect fittings such as J-lock fittings or similar. The disconnect fitting shall provide an air tight seal and shall not require the use of tools to disconnect the duct from the bin. Fitting shall be manufacture of 316 stainless steel.

PART 3 EXECUTION

3.1 FOUL AIR DUCTWORK INSTALLATION

- A. Examination: Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Preparation: Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

C. Installation-General:

1. Joint pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
2. Remove foreign objects prior to assembly and installation.

D. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
3. Use flat-face flange when joining with flat-faced FRP flange. Use minimum 1/4-inch thick neoprene gaskets.

3.2 BALANCING AIR FLOWS

- A. Contractor shall adjust dampers in ducts at source structures to achieve air flow balance. Air flow probes shall be used only for balancing each system and shall be removed from the ducts after the systems are balanced. Air flow probes and manometers shall become District property after balancing has been successfully completed and the odor control systems are operational and fully functioning. Air duct balancing shall be performed in accordance with Section 15954 -HVAC Systems Testing, Adjusting, and Balancing.

END OF SECTION

SECTION 02540 – PRECAST CONCRETE MANHOLES AND DROP INLETS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all prefabricated manholes, complete with adaptor rings, frame, cover, warning signs, pipe connection and cast-in-place or prefabricated base, and any other appurtenances, and drop inlets as shown and specified herein, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.
- B. Commercial Standards:
 - ASTM A48 Specification for Gray Iron Castings
 - ASTM A123 Specification for Zinc Coatings on Iron and Steel Products
 - ASTM A185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - ASTM A497 Specification for Steel Welded Wire Fabric, for Concrete Reinforcement Deformed
 - ASTM A615 Specification for Deformed and Plain Billet – Steel Bars for Concrete Reinforcement
 - ASTM C33 Specification for Concrete Aggregates
 - ASTM C150 Specification for Portland Cement
 - ASTM C478 Specification for Precast Reinforced Concrete Manhole Sections

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall furnish complete shop drawings for all precast manhole, curb inlet and drainage inlet sections; cast iron frames, grates and covers; and appurtenances for review by the Engineer in accordance with Section 01300-Submittals.
- B. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications and the reference standards.
- C. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

PART 2 PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

- A. Materials of construction: Manholes shall be constructed of precast concrete manhole rings as specified in ASTM C478. Precast concrete rings shall be manufactured by a process that will produce a dense, homogenous ring of first quality. The rings shall have a minimum wall thickness of 6 inches and be reinforced with either welded wire fabric (WWF), as specified in ASTM A185 or A497, or steel bars as specified in ASTM A615. Cement used in manufacturing the rings shall be Type II Portland cement as specified in ASTM C150. Aggregate shall conform to ASTM A615.

1. Mortar for bonding joints shall consist of one part cement to 2-1/2 parts of sand, by volume.
2. All manholes shall have concrete bases and drain manholes shall have formed channels with inverts to match the adjoining pipes.

- B. Coating/ Liners

1. Coating and Liners where required by the Contract documents shall be per contract drawings and meet the requirements of Section 09960 – Protective Coatings, or Section 06620 - PVC Liners.

- C. Manufacturers or Equal:

1. Hanson Precast
2. Central Precast

2.2 CASTINGS

- A. Performance requirements: Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A48, Class 30 as well as to the requirements of the contract drawings, if shown. Unless otherwise shown, cast iron covers and frames shall be heavy traffic type designed for H-20 traffic loading. Covers shall bolt to frame with stainless steel hardware. Covers shall be labeled with embossed lettering to designate the service.

- B. Manufacturer's or Equal:

1. D&L Foundry and Supply
2. South Bay Foundry, Inc

2.3 WARNING SIGNS

- A. Performance requirements: The entrance to every manhole UNO shall be fitted with a permanently affixed warning sign, located within the top 12-inches from the manhole cover against the wall, with the inscription "**CONFINED SPACE: PERMIT REQUIRED**"

BEFORE ENTRY" in clear, large lettering. The sign shall be attached to the concrete with four Type 316 stainless steel screws and anchors.

B. Manufacturer's or Equal:

1. W.H. Brady Company., Milwaukee, WI
2. Steton Nameplate Corporation., Branford, CT

2.4 CURB AND DRAINAGE INLETS

- A. Performance requirements: Curb and Drop inlets shall conform to applicable local standards with a structure and grating designed to withstand H-20 highway loading. Precast units shall be constructed for the job, with Manufacturer provided pipe openings. Grates shall be bicycle safe.
- B. Materials of Construction: Curb and drop inlets shall be precast reinforced concrete. Cement used in manufacturing shall be Type II Portland cement as specified in ASTM C150. Aggregate shall conform to ASTM C33. Reinforcing shall consist of welded wire fabric as specified in ASTM A185 or A497, or steel bars as specified in ASTM A615. Steel grates and frames shall be hot-dipped galvanized after fabrication to the requirements of ASTM A123.
- C. Manufacturer's or Equal:
1. Santa Rosa Precast, Santa Rosa, CA
 2. Associated Concrete Products, Costa Mesa, CA
 3. Ameron, Monterey Park, CA

PART 3 EXECUTION

3.1 INSTALLATION

- A. All precast concrete manholes and inlet structures shall be installed in strict conformance with the manufacturer's written instruction and as per the Drawings, on a well compacted foundation, as specified in Section 02200 – Earthwork.

3.2 TESTING

- A. General
1. Inspection: After installation, the Contractor shall demonstrate that all manholes have been properly installed, level, with tight joints, at the correct elevations and orientations and that the backfilling has been carried out in accordance with the Contract Documents.
- B. Functional Testing and Performance Testing
1. Manholes and inlets shall be tested as specified in Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

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SECTION 02565 – DUCTILE IRON PIPE (AWWA C151, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. CONTRACTOR shall furnish and install all ductile iron pipe and all appurtenant work, complete in place, including connections to existing and new structures, in accordance with the requirements of the CONTRACTOR Documents.
- B. The requirements of Section 02500 – Buried Pipe Installation apply unless stated otherwise herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ANSI
- B. AWWA

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 - Submittals, Section 02500 – Buried Pipe Installation, the requirements of the reference standards, and the following supplemental requirements.
 - 1. Materials lists and steel reinforcement schedules, as applicable, which describe all materials to be utilized.
 - 2. Design calculations for wall thickness for all pipe whose thickness is not specifically defined and for all restrained joint length requirements not specifically defined.
 - 3. Manufacturer's written Quality Assurance/Control Program.
 - 4. Certified dimensional drawings of all valves, fittings, and appurtenances.
- B. Certifications: CONTRACTOR shall furnish a certified affidavit of compliance to the ENGINEER guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:
 - 1. Physical and chemical properties for the material components of all pipe, specials and appurtenances.
 - 2. Hydrostatic test reports for pipe and rubber gaskets, where applicable.
 - 3. Results of production weld tests as applicable.
 - 4. Sand, cement and mortar tests as applicable.
 - 5. Rubber gasket tests, as applicable.

- C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increased cost to the OWNER.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
- B. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- C. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- D. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- E. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

- A. Mortar-lined and polyethylene encased ductile iron pipe shall conform to ANSI/AWWA C151, C104, and C105, subject to the modifications contained herein. The pipe shall be of the diameter and class shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.
- B. Laying Lengths: Maximum pipe laying lengths shall be 20 ft with shorter lengths provided as required by the Drawings.
- C. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.
- D. Bonding and Electrical Conductivity: All pipe joints shall be prepared for bonding for electrical conductivity in accordance with the details shown. The CONTRACTOR shall furnish all materials required for joint bonding and electrolysis test station installations.
- E. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings.

2.2 MATERIAL

- A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.
- B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

2.3 SPECIALS AND FITTINGS

- A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure as shown on the Drawings for the higher class of adjoining pipe.

2.4 DESIGN OF PIPE

- A. General: The pipe furnished shall be ductile iron pipe, mortar-lined and polyethylene-encased, with rubber-gasketed joints.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C151.
- C. Pipe Dimensions: The pipe shall be of the diameter and class shown on the Contract Drawings.
- D. Fitting Dimensions: The fittings shall be of the diameter and class shown.
- E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.
 - 1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11
 - 2. Flanged joints shall conform to ANSI/AWWA C115/A21.15. Gaskets shall be 1/8-inch thick, full face, cloth inserted rubber, corrosive acid and alkali free conforming to ANSI B16.21 and ANSI/AWWA C207.
 - 3. Restrained joints shall be "Megalug" by EBAA Iron Inc., or equal.
- F. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.5 CEMENT-MORTAR LINING

- A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has

been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

- B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in)	Minimum Lining Thickness (in)
3 to 12	1/8
14 to 24	3/16
30 to 54	1/4

- C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.6 EXTERIOR COATING OF PIPE

- A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09960 – Protective Coatings.

2.7 EXTERIOR COATING OF BURIED PIPING:

- A. Buried ductile iron pipe, joints, valves and fittings shall be encased in a polyethylene film that meets the material specifications of ANSI/AWWA C105/A21.5. Tape used in the installation of the polyethylene film shall be polyethylene.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.

3.2 INSTALLATION

- A. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600 and the provisions of Section 02500 – Buried Pipe Installation.

3.3 EXTERIOR COATING

- A. Polyethylene encasement shall be installed on ductile iron pipe, joints, valves and fittings in accordance with the requirements of ANSI/AWWA C105/A21.5.

3.4 RUBBER-GASKETED JOINTS

- A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.5 CORROSION CONTROL

- A. Electrical Continuity: Except where otherwise specified, all non-welded joints shall be bonded in accordance with the details shown. The pipe shall be cleaned to bare bright metal at the point where the bond is installed and the bond wire installed utilizing procedures in accordance with the requirements of Section 13115 – Cathodic Protection, and as shown in the Drawings.
- B. Electrical Insulation: All buried pipelines shall be electrically isolated from reinforcing bars as building/structure penetrations.
- C. Cathodic Protection: All buried piping and fittings shall be provided with cathodic protection consisting of magnesium anodes or backfilled with controlled low strength backfill in accordance with the requirements of Section 13115 – Cathodic Protection, and as shown in the Drawings.

3.6 FIELD COATING OF EXPOSED PIPE

- A. Apply field coating to all exposed pipe in accordance with Section 09960 – Protective Coatings.

END OF SECTION

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SECTION 02571 – STEEL PIPE, LINED AND COATED

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all lined and coated steel pipe, fittings, steel plate specials and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01300 - Submittals, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.
 - 1. Joint and pipe/fitting wall construction details which indicate the type and thickness of cylinder; the position, type, size, and area of reinforcement; coating and lining holdbacks, manufacturing tolerances; and all other pertinent information required for the manufacture of the product.
 - 2. Fittings and specials details such as elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials which indicate amount and position of all reinforcement.
 - 3. Design calculations (including a complete stress analysis) of each girth joint and specials – all sufficient to ascertain conformance of pipe and fittings with the Specifications. These shall be submitted to the Engineer for review prior to manufacture of pipe specials.
 - 4. Material lists and steel reinforcement schedules that describe all materials to be utilized.
 - 5. Design calculations for wall thickness for all pipe whose thickness is not specifically defined and for all restrained joint length requirements not specifically defined.
 - 6. Line layout and marking diagrams that indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; and the limits within each reach of restrained and/or welded joints or of concrete encasement.
 - 7. Full and complete information regarding location, type, size, and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints, and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are

especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

8. Rubber gasket joint design and details.
9. Drawings showing the location, design, and details of bulkheads for hydrostatic testing of the pipeline, and details for removal of test bulkheads and repair of the lining.
10. Details and locations of closures for length adjustment and for construction convenience.
11. Detail drawings indicating the type, number, and other pertinent details of the slings, strutting, and other methods proposed for pipe handling during manufacturing, transport, and installation.
12. Manufacturer's written Quality Assurance/Control Program.
13. Calculations for reinforcement on all fittings and specials to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions specified and shown.
14. Manufacturer's written Quality Assurance/Control Program.
15. Certified dimensional drawings of all valves, fittings, and appurtenances.

B. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:

1. Physical and chemical properties for the material components of all pipe, specials and appurtenances.
2. Hydrostatic test reports for pipe and rubber gaskets, where applicable.
3. Results of production weld tests as applicable.
4. Sand, cement and mortar tests as applicable.
5. Rubber gasket tests, as applicable.

C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.3 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

- C. Tests: Except as specified herein, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of ANSI/AWWA C200 and C205, as applicable.
1. Joint gaskets shall be tested in accordance with ANSI/AWWA C200.
 2. After the joint configuration is completed and prior to lining with-cement-mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 80 percent of the yield strength of the steel.
 3. In addition to the tests required in ANSI/AWWA C200, weld tests shall be conducted on each 5,000 feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment.
 4. If any special has been fabricated from straight pipe not previously tested and is of the type listed below, the special shall be hydrostatically tested with a pressure equal to 1-1/2 times the design working pressure: All bends, wyes, crosses, tees with side outlet diameter greater than 30 percent of the main pipe diameter, and manifolds.
 5. All specials not required to be hydrostatically tested shall be tested by liquid dye penetrant inspection method in accordance with ASTM E 165 - Methods for Liquid Penetrant Inspection, Method A or the magnetic particle method in ASME Section VIII, Division 1, Appendix VI.
 6. Reinforcing plates shall be tested by the solution method using approximately 40 psi air pressure introduced between the plates through a threaded test hole. Test hole shall be properly plugged following successful testing.
 7. Any weld defects, cracks, leaks, distortion, or signs of distress during testing shall require corrective measures. Weld defects shall be gouged out and rewelded. After corrections, the special shall be retested.
 8. Where welded test heads or bulkheads are used, extra length shall be provided to each opening of the special. After removal of each test head, the special shall be trimmed back to the design points with all finished plate edges ground smooth, straight, and prepared for the field joint.
 9. Testing shall be performed before joints have been coated or lined
- E. Ultrasonic Examination:
1. Steel plate that will be in welded joints or welded stiffener elements shall be examined ultrasonically for laminar discontinuities where both of the following conditions exist:
 - a. Any plate in the welded joint has a thickness exceeding 1/2-inch.
 - b. Any plate in the welded joint is subject to transverse tensile stress through its thickness during the welding or service.

2. Ultrasonic examination may be waived where joints are designated to minimize potential laminar tearing.
 3. The ultrasonic examination shall be in accordance with ASTM A 578 - Straight Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications with a Level I acceptance standard.
 4. Plates that are not in conformance with the acceptance criteria in ASTM A 578 may be used in the Work if the areas that contain the discontinuities are a distance at least four times the greatest dimension of the discontinuity away from the weld joint.
- F. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.
- G. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1 or ASME Pressure Vessel Code, Section 9. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.
- H. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or ASME Pressure Vessel Code, Section 9 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. Mortar-lined and mortar-coated steel pipe shall conform to ANSI/AWWA C200 and C205, subject to the following supplemental requirements. The pipe shall be of the diameter and class indicated, allowing for tolerances according to ANSI/AWWA C200 and C205, shall be provided complete with rubber gaskets or welded joints, as indicated in the Contract Documents, and all specials and bends shall be provided as required in this section.
- B. Fusion bonded epoxy lined and coated steel pipe shall conform to ANSI/AWWA C200 and C213. The pipe shall be of the diameter and class indicated, allowing for tolerances according to ANSI/AWWA C200, shall be provided complete with rubber gaskets or welded joints, as indicated in the Contract Documents, and all specials and bends shall be provided as required in this section.
- C. Steel piping shall be of the diameter and wall thickness as indicated in the Contract Documents. For pipe 14 inches in diameter and larger, the nominal inside diameter after any lining is applied shall not be less than the diameter shown on the Drawings, allowing for tolerances according to applicable standards. Pipe smaller than 14 inches in diameter may be furnished in standard outside diameters.

- D. Strutting: Adequate strutting shall be provided on all specials, fittings, and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling, and installation. Details of the strutting assembly shall be submitted for review by the Engineer prior to start of pipe manufacture.
- E. Laying Lengths: Maximum pipe laying lengths shall be 48 ft with shorter lengths provided as required by the Drawings.
- F. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing indicated. The locations of correction pieces and closure assemblies are shown. Any change in location or number of said items will have to be approved by the Engineer.
- G. All vertical deflections shall fall on the alignment and at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures. The pipe angle points shall match the angle points shown.

2.2 MATERIALS

- A. Mortar: Materials for mortar shall conform to the requirements of ANSI/AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-inch and Larger - Shop Applied; provided, that cement for mortar coating shall be Type II, and mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement. Admixtures shall contain no calcium chloride
- B. Fusion Bonded Epoxy: Fusion bonded epoxy lining and coating shall be in accordance with Section 09960 Protective Coatings unless noted otherwise.
- C. Steel for Cylinder and Fittings: Pipe manufactured under ANSI/AWWA C200 shall satisfy the following requirements:
 - 1. Minimum yield strength of steel for pipe is 33,000 psi.
 - 2. Be manufactured by a continuous casting process and be fully killed.
 - 3. Be fine grain practice.
 - 4. Have maximum carbon content of 0.25 percent.
 - 5. Have maximum sulfur content of 0.015 percent.
 - 6. Have minimum elongation of 22 percent in a 2-inch gauge length.
 - 7. Be in accordance with one of the following:
 - a. ASTM A 1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
 - b. ASTM A 36 - Structural Steel
 - c. ASTM A 283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars

d. ASTM A 572 - High Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality

- D. Steel equal to or greater than 1/2-inch thick used in fabricating pipe shall be tested for notch toughness using the Charpy V-Notch test in accordance with ASTM A 370 - Test Methods and Definitions for Mechanical Testing of Steel Products. Frequency of testing shall be one impact test (set of 3 specimens) for each coil used in manufacturing the pipe. The frequency for sheets and plates shall be one impact test (set of 3 specimens) and shall be made for each 30 tons of product. The steel shall withstand a minimum impact of 25 ft-lb at a temperature of 30 degrees F.

2.3 SPECIALS AND FITTINGS

- A. Specials are defined as fittings, closure pieces, bends, reducers, wyes, tees, crosses, outlets, manifolds, and other steel plate specials wherever located, and all piping above ground or in structures.
- B. Reinforcement for wyes, tees, outlets, and nozzles shall be designed in accordance with AWWA Manual M-11. Reinforcement shall be designed for the design pressure indicated and shall be in accordance with the Drawings. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise indicated, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.
- C. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths of pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Bevel-end joints shall not be pulled. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be in accordance with the manufacturer's recommendations or the angle which results from a 3/4-inch pull out from normal joint closure, whichever is less. All horizontal deflections or fabricated angles shall fall on the alignment.
- D. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials as used for the pipe and in accordance with the applicable AWWA or ASTM Standards, as modified by the applicable pipe section in these Specifications. Coating and lining applied in this manner shall provide protection equal to that for the pipe. Fittings may be fabricated from pipe that has been mechanically lined and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-applications.
- E. Outlets, Tees, Wyes, and Crosses
1. Outlets 12-inch and smaller may be fabricated from Schedule 30 or heavier steel pipe in the standard outside diameters, i.e., 12-3/4-inch, 10-3/4-inch, 8-5/8-inch, 6-5/8-inch, and 4-1/2-inch. Minimum plate thickness for reinforcements shall be 10-gauge.
 2. The design of outlet reinforcement shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M-11, and the design pressures and factors of safety above.

3. In lieu of saddle or wrapper reinforcement as provided by the design procedure in Manual M-11, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
 4. Where Manual M-11 requires the design procedure for crotch plate reinforcement, such reinforcement shall be provided.
 5. Outlets shall be fabricated so that there is always at least a 12-inch distance between the outer edge of the reinforcing plate and any field welded joints. For outlets without reinforcing plates, outlets shall penetrate the steel cylinders so that there is at least a 12-inch clearance between the outlet and any field welded joints.
- F. Tees, wyes, crosses, elbows, and manifolds shall be fabricated so that the outlet clearances and reinforcing plates from any weld joints are a minimum of 5 times cylinder thickness or 2 inches, whichever is greater. Longitudinal weld joints in adjacent cylinder sections shall be oriented so that there is a minimum offset of 5 times cylinder thickness or 2 inches, whichever is greater.
 - G. Steel welding fittings shall conform to ASTM A 234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
 - H. Ends for Mechanical-Type Couplings: Except as otherwise indicated, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved

2.4 DESIGN OF PIPE AND SPECIALS

- A. General: The pipe shall be steel pipe, lined and coated, with rubber gasketed or field welded joints as indicated. The pipe shall consist of a steel cylinder, either shop-lined or lined-in-place with portland cement-mortar or fusion bonded epoxy.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and, except as hereinafter modified, shall conform to ANSI/AWWA C200.
- C. Design: Except as otherwise indicated, materials, fabrication and shop testing of straight pipe shall conform to the requirements of ANSI/AWWA C200 - Steel Water Pipe 4 in and Larger, and shall conform to the dimensions of ANSI/AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings. Unless otherwise noted in the Contract Documents, the minimum thickness of plate for pipe from which specials are to be fabricated shall be the greater of that determined by the following five criteria:

1. Working and Transient Pressure Design

$$T = \frac{P_w D / 2}{Y / S_w}$$

$$T = \frac{P_t D / 2}{Y / S_t}$$

Where:

T	=	Steel cylinder thickness in inches
D	=	Outside diameter of steel cylinder in inches
P _w	=	Design working pressure in psi

P_t	=	Design transient pressure in psi
Y	=	Specified minimum yield point of steel in psi
S_w	=	Safety factor of 2.5 at design working pressure
S_t	=	Safety factor at design transient pressure; for elbows 1.875, and 2.0 for other specials

2. Mainline Pipe Thickness: Plate thickness for specials shall not be less than for the adjacent mainline pipe.
3. Thickness based on Pipe Diameter:

Nominal Pipe Diameter (in)	Pipe Manifolds Piping Above Ground Piping Structures	Elbows Bends Reducers
24 and under	3/16-in	Sch. 30
25 to 48	1/4-in	1/4-in
over 48	5/16-in	5/16-in

4. Specials installed on saddle supports shall be designed to limit the longitudinal bending stress to a maximum of 10,000 psi. Design shall be in accordance with the provisions of Chapter 7 of AWWA M-11.
5. For resistance to external load on buried pipe and for handling and transport, the thickness of the steel cylinder shall not be less than the thickness of adjacent mainline pipe or the cylinder thicknesses specified in the following table:

Nominal Pipe Diameter (in)	Minimum Cylinder Thickness at 95% Std. Proctor (in)	Cover Where Lean Concrete Encasement Required (ft)	Cover Where Reinf. Concrete Encasement Required (ft)
18 and under	0.1875	over 38	over 43
over 18 to 24	0.1875	over 22	over 27
over 24 to 36	0.250	over 15	over 20
over 36 to 48	0.250	over 11	over 17
over 48 to 60	0.3125	over 11	over 16
over 60 to 72	Nom. Diam./192	over 10	over 16

In no case shall the vertical deflection of the pipe exceed 1.5 percent of the nominal diameter.

- D. Minimum wall thickness shall include zero minus mill tolerances.
- E. Fitting Dimensions: The fittings shall be of the diameter and class shown.
- F. Joint Design: Unless indicated otherwise, the standard field joint for steel pipe shall be a rubber gasket joint. For buried steel pipe greater than 12-inches, field joints shall be welded lap joint (single). Welded joints shall be provided where indicated. Butt-strap joints shall be used only where required for closures or where shown.

- G. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200. The method used to form, shape, and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.
- H. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted. Unless otherwise approved by the Engineer, bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. No process will be permitted in which the bell is formed by rolling. Spiral weld seams shall be tested by the visible penetrant method of ASTM E 165 - Methods for Liquid Penetrant Inspection or magnetic particle inspection method of ASME Section VIII, Division 1, Appendix VI, for a minimum distance of 12 inches from each end of each joint after the spigot and bell are formed. Defects shall be repaired.
- I. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as indicated or as otherwise acceptable to the Engineer.
- J. Restrained Joints
 - 1. Located where indicated, restrained joints shall be field-welded joints, either single, or inside and outside (double) lap-weld, or butt-weld, or butt-straps as indicated. Designs shall include stresses created by the greater of:
 - a. Temperature differential of 40 degrees F plus Poisson's effect in combination with hoop stress, or;
 - b. Thrust due to bulkheads, bends, reducers, and line valves resulting from working pressure in combination with hoop stress.
 - 2. For field welded joints, design hoop stresses shall not exceed 18,000 psi. At the Contractor's option, the steel cylinder area may be progressively reduced from the point of maximum thrust to the end of the restrained length.

2.5 CEMENT-MORTAR LINING

- A. Cement-Mortar Lining for Shop Application: Unless indicated otherwise, interior surfaces of all pipe and specials, shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work and shall be approved by the Engineer. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications at no additional cost to the Owner.

- B. The minimum lining thickness and tolerance shall be in accordance with ANSI/AWWA C205.
- C. The pipe shall be left bare as indicated where field joints occur. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.
- D. Defective linings, as determined by the Engineer, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather-edged joints.
- E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of ANSI/AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.
- F. Cement-Mortar Lining for Field Application: The materials and design of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602 - Cement-Mortar Lining of Water Pipeline-4 in and Larger-Shop Applied. The minimum lining thickness and finished inside diameter shall be as indicated for shop-applied cement-mortar lining.
- G. Protection of Pipe Lining/Interior: For all pipe and fittings with plant-applied or cement-mortar linings, the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.
- H. The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

2.6 EXTERIOR MORTAR COATING OF PIPE

- A. Exterior Mortar Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09960 – Protective Coatings.
- B. Exterior Coating of Buried Piping: All pipe and specials for buried service, including bumped heads, shall be coated with a 1-inch minimum thickness of reinforced cement-mortar coating. Unless otherwise indicated, exterior surfaces of pipe, specials or fittings passing through structure walls shall be cement-mortar coated from the center of the wall or from the wall flange, if indicated, to the end of the underground portion of pipe or fitting. The coating shall be reinforced with a spiral wire reinforcement or welded wire fabric in accordance with ANSI/AWWA C205. The welded wire fabric shall be securely fastened to the pipe with welded clips or strips of steel. The wire spaced 2 inches on centers shall extend circumferentially around the pipe. The ends of reinforcement strips shall be lapped 4 inches and the free ends tied or looped to assure continuity of the reinforcement.

2.7 FUSION-BONDED EPOXY COATING AND LINING

- A. General: Except as described below, the material system for the exterior and interior of steel pipe and fittings installed underground or underwater shall be in accordance with ANSI/AWWA C213.

- B. Minimum Pipe Diameter: The minimum pipe diameter for application of an internal lining shall be 6 inches for welded joint pipe, and 4 inches for gasketed joint pipe.
- C. Maximum Temperature: This material system shall be able to withstand a maximum service temperature of 190° F.
- D. Thickness: The powder shall be applied to the preheated pipe at a uniform cured thickness. The minimum nominal uniform cured thickness of the applied material shall be as follows:
 - 1. Interior, 16 mils minimum
 - 2. Exterior, 14 mils minimum
 - 3. Maximum thickness shall be determined by the applicator based on the roughness of the pipe so as to obtain a holiday free product. Lining and coating thickness for pipe joints shall be compatible with dimensional tolerances.
- E. Field-Welded Joints: The repair of field-welds shall be per Section 3.5 of ANSI/AWWA C213, EXCEPT that Subsection 3.5.3 shall not be used for the internal repair. After joint repair the joint shall be tested for continuity per Subsection G.2 below.
- F. Blast Cleaning: The pipe surfaces to be covered in the plant shall be blast-cleaned with steel grit to achieve a near white surface conforming to SSPC-SP10 per Section 09960 Protective Coatings.
- G. Continuity Tests:
 - 1. Interior of pipe shall be electrically inspected for continuity at 2100 volts. At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe 20 inches O.D. or smaller, or one per 2 linear feet of pipe over 20 inches O.D., the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of the ANSI/AWWA C213 specifications.
 - 2. Exterior of pipe shall be electrically inspected for continuity at 1965 volts. At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe length for pipe smaller than 14 inches O.D., or one per 25 square feet of surface area for pipe 14 inches in O.D. and larger, the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of the ANSI/AWWA C213 specifications.
 - 3. Coating Repair and Field Touch-Up: If gasketed joint pipe is used, exothermic weld connections for the installation of bond cables across joints of the pipeline for cathodic protection shall be repaired and touched-up with 3M-312 material or equal.

2.8 PIPE APPURTENANCES

- A. Pipe appurtenances shall be in accordance with the requirements of Division 15 of the Specifications. Access manholes with covers shall be as indicated, installed during fabrication, not in the field. Threaded outlets shall be forged steel suitable for 3000 psi service, and shall be as manufactured by Vogt, or equal.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.
- B. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. Struts in pipe smaller than 42 inches may be removed immediately after laying. A laboratory selected and paid by the Owner may monitor pipe deflection by measuring pipe inside diameter before struts are removed and 24 hours after struts are removed. Pipe deflection shall not exceed 1.25 percent 24 hours after the struts are removed. After the backfill has been placed, the struts shall be removed and shall remain the property of the Contractor. For mortar-lined or mortar-coated steel pipe, the following requirements shall apply:
 - 1. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed, and backfilled at the jobsite.
 - 2. The strutting materials, size and spacing shall be adequate to support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment.
 - 3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.

3.2 INSTALLATION OF PIPE

- A. Joints
 - 1. Rubber Gaskets
 - a. Rubber Gasketed Joints: Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the spigot groove. The lubricant shall be a compound listed as in compliance with NSF Standard 61. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with the vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gage shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be "felt" all around, the joint shall be disassembled. The joint shall be reassembled with a new gasket.
 - 2. Welded Joints
 - a. Welded joints shall be provided where indicated.
 - b. General: Field welded joints shall be in accordance with ANSI/AWWA C206 - Field Welding of Steel Water Pipe.

- c. During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that, at any point around the circumference of the joint, there is a minimum lap of 1/2-inch and a minimum space of 3/4-inch plus the thickness of the steel pipe wall between the spigot end of the pipe and the nearest tangent to a bell radius.
- d. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.
- e. Butt straps shall be as indicated, shall be a minimum of 6 inches wide, the same thickness as the pipe wall, and shall provide for a minimum 2-inch lap at each pipe joint.
- f. After the pipe and joint are properly positioned in the trench, the length of pipe between joints shall be backfilled to at least one foot above the top of the pipe. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the joint.
- g. To control temperature stresses, the unbackfilled joint areas of the pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials for a minimum period of 2 hours prior to the beginning of the welding operation and until the weld has been completed. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.
- h. Shrinkage Control Joints: At intervals not exceeding 250 feet along welded reaches of the pipeline and at the first regular lap-welded field joints outside concrete encasements and structures, the pipe shall be laid with an initial lap of not less than 1-inch greater than the minimum lap dimension. The welding of each such shrinkage control joint shall be performed when the temperature is approximately the lowest during the 24-hour day, after at least 250 feet of pipe have been laid and the joints have been welded ahead of and in back of the shrinkage control joint, and after backfill has been completed to at least 1-foot above the top of the pipe ahead of and in back of the shrinkage control joint. Where shrinkage control joints occur in a traveled roadway or other inconvenient location, the location of the shrinkage control joint may be adjusted, as acceptable to the Engineer.
- i. Prior to the beginning of the welding procedure, any tack welds used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with ANSI/AWWA C206. Where more than one pass is required, all dirt, slag, and flux shall be removed before the succeeding bead is applied.
- j. Prior to butt welding, the pipe and joint shall be properly positioned in the trench using line up clamps so that, in the finished joint, the abutting pipe sections shall not be misaligned more than 1/16-inch.
- k. Joints: The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as indicated.
- l. Unless double fillet welds are shown on the Drawings, field welded lap joints may, at the Contractor's option, be made on either the inside or the outside of the pipe.
- m. Inspection of Field Welded Joints: An independent testing laboratory acceptable to the Engineer but paid by the Contractor at no increased cost to the Owner shall inspect the joints. Inspection shall be as soon as practicable after the welds are completed.

- 1) Fillet welds shall be tested by the Magnetic Particle Inspection Method in accordance with ASME Section VIII, Division 1, Appendix VI.
- 2) In addition, double fillet welds on butt strap joints shall be tested by the soap solution method using approximately 40 psi air pressure introduced between the plates through a threaded hole as indicated. Test holes shall be plugged by a threaded plug or welding following successful testing.
- 3) Butt welds shall be inspected by radiographic methods in accordance with API Standard 1104.

3. Joint Mortar Coating and Mortar Lining

- a. Pipe and Specials Protection: The Contractor shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads.
- b. Following tests of the joint, the exterior joint spaces shall be coated in accordance with these specifications after which backfilling may be completed.
- c. Where butt-straps or closure pieces are used, both the interior and exterior surfaces of the butt-straps or closure pieces shall be given a coating equivalent to the factory-applied coating of the adjoining pipe sections. Any exterior cement mortar coating in such cases shall be reinforced with wire mesh. Any interior cement mortar lining shall be similarly reinforced, where the exposed length of the butt-straps or closure piece, as measured between the ends of connected pipe sections, exceeds 4 inches.
- d. General: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt, and other foreign material shall be removed from the inside surface of the pipe. The grout for joint coating and lining shall be cement grout in accordance with Section 03600 – Grouts, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency for joint linings and thick cream consistency for joint coatings.
- e. Joint Coating: After the pipe has been laid and after sufficient backfill has been placed between the joints to hold the pipe securely in place, the outside annular space between pipe sections shall be completely filled with grout formed by the use of polyethylene foam-lined fabric bands. The grout space shall be flushed with water prior to filling so that the surface of the joint to be in contact with the grout will be thoroughly moistened when the grout is poured. The joint shall be filled with grout by pouring from one side only, and shall be rodded with a wire or other flexible rod or vibrated so that the grout completely fills the joint recess by moving down one side of the pipe, around the bottom of the pipe and up the opposite side. Pouring and rodding the grout shall be continued to allow completion of the filling of the entire joint recess in one operation. Care shall be taken to leave no unfilled space. Grouting of the outside joint spaces shall be kept as close behind the laying of the pipe as possible except that in no case shall grouting be closer than 3 joints of the pipe being laid.
- f. Similarly, in the case of mortar-coated pipe, after the coupled or flanged joint is completed, the coupling, flange, or bare metal of the pipe shall be cleaned, primed, and coated with a minimum thickness of 1-inch of cement mortar, having one part cement to not more than 2 parts plaster sand.
- g. Grout Bands (Diapers): The grout bands or heavy-duty diapers shall be polyethylene foam-lined fabric with steel strapping of sufficient strength to hold the fresh mortar, resist rodding of the mortar, and allow excess water

to escape. The foam plastic shall be 100 percent closed cell, chemically inert, insoluble in water and resistant to acids alkalis and solvents, and shall be Dow Chemical Company, Ethafoam 222, or equal.

- h. The fabric backing shall be cut and sewn into 9-inch wide strips with slots for the steel strapping on the outer edges. The polyethylene foam shall be cut into strips 6 inches wide and slit to a thickness of 1/4-inch which will expose a hollow or open cell surface on one side. The foam liner shall be attached to the fabric backing with the open or hollow cells facing towards the pipe. The foam strip shall cover the full interior circumference of the grout band with sufficient length to permit an 8-inch overlap of the foam at or near the top of the pipe joint. Splices to provide continuity of the material will be permitted. The polyethylene foam material shall be protected from direct sunlight.
- i. The polyethylene foam-lined grout band shall be centered over the joint space with approximately equal widths extending over each pipe end and securely attached to the pipe with the steel straps. After filling the exterior joint space with grout, the flaps shall be closed and overlapped in a manner that fully encloses the grout with polyethylene foam. The grout band shall remain in position on the pipe joint.
- j. Joint Lining: After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. The grout for joint coating and lining shall be cement grout in accordance with Section 03600 – Grout, except that composition shall be one part cement to two parts sand and sufficient water for dry-pack consistency. The grout shall be tightly packed into the joint recess and troweled flush with the interior surface. All excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout containing one part cement to two parts sand. The joint shall be completed and excess mortar on the inside of the joint shall be swabbed out.
- k. Cement-Mortar Lining, Field-Applied: For pipe diameters of 60 in or larger, the Contractor may construct the cement-mortar lining in-place. The application of in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602.
- l. The lining machine shall be of a type that has been used successfully for a similar size of pipe. The Contractor shall perform all work in a thorough and workmanlike manner by trained personnel under the supervision of experienced personnel skilled in machine application of cement-mortar lining to pipelines of size comparable to this Work.
 - 1) Curing of the in-place cement-mortar lining shall be in accordance with ANSI/AWWA C602. The Contractor shall provide additional protective devices as required to ensure that the airtight covers, which maintain a moist condition in the pipeline, are not damaged.
 - 2) Defective areas encompassing the full circumference of the pipe shall be replaced by machine wherever the length measured along the pipe centerline is greater than 5 feet; otherwise defective areas may be replaced by hand.

3.3 TESTING

- A. Testing of lined and coated pipe shall be in accordance with Section 02500 – Buried Pipe Installation, Section 02640 – Pipeline Testing and Disinfection, referenced standards and the additional requirements in this Section.

- B. Where required by the Engineer, all pipe, 36 inches in diameter and larger, which has been installed and backfilled to the minimum required compaction, shall be tested by the Contractor in the presence of the Engineer to insure that the vertical deflections for welded steel pipe do not exceed the maximum allowable deflection specified. Deflection tests shall be performed not sooner than 30 days after completion of placement and densification of backfill and removal of pipe struts, if any. The Contractor shall submit to the Engineer for acceptance, the method proposed to determine the deflections. Unless otherwise permitted by the Engineer, any overdeflected pipe shall be uncovered and, if not damaged, reinstalled. Damaged pipe shall not be reinstalled but shall be removed from the jobsite. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any over deflection, shall be uncovered, removed from the jobsite, and replaced with new pipe. All costs incurred by the Contractor attributable to deflection testing, including any delays, shall be borne by the Contractor at no cost to the Owner.
- C. Repair of Welds: All welds that are defective shall be repaired by the Contractor to meet the requirements of the applicable sections of these specifications at no additional cost to the Owner. Defects in welds or defective welds shall be removed, and that section of the joint shall then be rewelded. Only sufficient removal of defective material that is necessary to correct the defect is required. After the repair is made, the joint shall be checked by repeating the original test procedure. Welds deficient in size shall be repaired by adding weld metal.

3.4 INSTALLATION OF PIPE APPURTENANCES

- A. Protection of Appurtenances: Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than 2 parts plaster sand.
- B. Insulated Joints: Insulated joints and appurtenant features shall be provided as indicated. The Contractor shall exercise special care when installing these joints to prevent electrical conductivity across the joint. After the insulated joint is completed, an electrical resistance test shall be performed by the Contractor. Should the resistance test indicate a short circuit, the Contractor shall remove the insulating units to inspect for damage, replace all damaged portions, and reassemble the insulating joint. The insulated joint shall then be retested to assure proper insulation.

3.5 CORROSION CONTROL

- A. Joint Bonding/Electrolysis Test Stations: Except where otherwise indicated, all gasketed joints shall be bonded in accordance with the Drawings. The pipe shall be cleaned to bare bright metal at the point where the bond is installed. In addition, electrolysis test stations shall be installed where indicated.

END OF SECTION

SECTION 02590– HIGH DENSITY POLYETHYLENE PRESSURE PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install all High Density Polyethylene (HDPE) pressure pipe and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.
- B. ASTM
- C. AWWA
- D. ASME
- E. ANSL
- F. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The CONTRACTOR shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01300 - Submittals, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.
 - 1. Shop drawings and descriptive literature showing pipe dimensions, joints, and other details for each size of pipe indicated.
 - 2. Certification from manufacturer with each delivery that pipe complies with this specification.
 - 3. Certified copies of test reports with each delivery, stated compliance with ASTM F714 and ASTM D3350 as appropriate.
 - 4. If the CONTRACTOR proposes any deviations from the design alignment, for example using a curve instead of a fitting where a PI or VPI is shown, appropriate information must be submitted, including manufacturer's recommended minimum allowable bend radius of pipe. The ENGINEER reserves the right to require a larger minimum radius.

5. Pipe manufacturers' joint assembly procedure including cool down time and datalogger equipment.
6. HDPE Fusion Technician's experience and qualifications. Submit written certification from the HDPE pipe fusion equipment supplier that the fusion technician has received training in the proper use of the fusion equipment and the manufacturer's recommended fusion equipment.
7. Description of pressure and leakage test procedures to be used. Description of all testing equipment to be used during pressure and leakage testing.
8. Manufacturer's written Quality Assurance/Quality Control Program.
9. Certified dimensional drawings of all valves, fittings and appurtenances.

B. Samples

1. Wall Uniformity Samples: The purpose of these samples is to visually check wall uniformity to determine if the HDPE resin pellets fully melted during the extrusion process.
 - a. The OWNER will select 5 sticks from the total number of sticks of each size and DR delivered to the project which to obtain a sample from.
 - b. Each sample will be five feet long and will come from the end of the pipe.
 - c. After the OWNER selects a sample, the CONTRACTOR shall cut the sample from the pipe and load the sample onto the OWNER's truck.
 - d. The exposed cross-section will be examined for uniform color, appearance, consistency, and other properties.
 - e. The samples will be stored for future testing if needed.

C. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance to the ENGINEER guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications and the reference standards.

D. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increased cost to the OWNER.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications

- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.
- E. HDPE Fusion Technician
 - 1. Technician making fusion bonded joints shall be employed or trained by the fusion equipment manufacturer.
 - 2. The technician making the fusion bonded joints shall have the following minimum experience:
 - a. Performed fusion bonding on at least three prior projects
 - b. Performed fusion bonding on at least 5,000 feet of 6-inch (or larger) HDPE pipe.
- F. HDPE Fusion Measurements
 - 1. Fusion machine heater plate surface temperatures and hydraulic cylinder interface pressures shall be recorded during the butt-fusion joining operations. Measurements shall be permanently recorded utilizing a McElroy Datalogger or OWNER-approved equal.
 - 2. Recorded fusion data shall be submitted to the OWNER within two days following the completion of any joint. Failure to submit this information may result in the joint being rejected and replaced.

PART 2 PRODUCTS

2.1 PIPE

- A. Pipe shall be high molecular weight, high density polyethylene pipe (HDPE).
- B. Pipe Material Designations
 - 1. Pipe material for all service shall be listed by the Plastic Pipe Institute (PPI) with a designation of PE 3408 and have a minimum cell classification of 345464C, D or E as described in ASTM D3350. The pipe shall have wall thickness as prescribed in the Pipe Schedule.
- C. The pipe material shall meet the requirements for Type III, Class B, Category 5, Grade P34 material as described in ASTM D1248.
- D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw pipe material.

- E. Pipe installed above grade, shall be black pipe (containing 2.0% minimum carbon black) and coating in accordance with 09960 Protective Coatings.
- F. Pipe and fittings shall be made in conformance with ASTM F714 and ASTM D3261 as modified for the specified material.
- G. The pipe shall be homogeneous throughout and free of cracks, holes, foreign inclusions or other injurious defects. It shall be uniform in density and other physical properties.
- H. Any pipe not meeting these criteria shall be rejected and taken from the site.
- I. Pipe shall conform to the nominal sizes and standard dimension ratios shown on the Pipe Schedule (see Drawings).
- J. Manufacturers, or Equal
 - 1. CP Chem (Chevron Phillips Chemical Company). Represented by P&F Distributors.
 - 2. Rinker Materials. Represented by Maskell-Robbins.
 - 3. Quail Pipe Corporation. Represented by Maskell-Robbins.
 - 4. KWH Pipe Corporation.

2.2 JOINTS

- A. General
 - 1. Joints shall be butt fusion joints, socket fusion joints, flanged joints, or electro-fusion joints. Friction or pressure couplings are not acceptable, unless specifically noted otherwise.
- B. Butt Fusion Joints
 - 1. Butt fusion techniques shall meet all requirements of ASTM D2657 and D3261.
 - 2. Butt fusion between pipes that are more than two DR steps different is not allowed. A transition fitting shall be required to connect pipes more than two DR steps different. A transition fitting shall be a short plain pipe with one end taper bored to match the thinner walled pipe. For example, to connect DR 11 and DR 21 pipe, a plain piece of DR 11 pipe with one end taper bored to DR 21 shall be used.
- C. Socket Fusion Joints
 - 1. Socket fusion techniques shall meet all requirements of ASTM D2657.
 - 2. Socket fusion equipment shall meet all requirements of ASTM F1056.
- D. Flanged Joints
 - 1. All flanged joints shall consist of HDPE flange adaptors and backup rings.

2. Full face flat ring gaskets of 1/8-inch black reinforced rubber conforming to ANSI B-16.21 shall be installed between the opposing ends of the flange adapters. Gaskets shall have bolt holes and be held in position by the bolts.
3. All backup rings (flanges) shall be polypropylene encapsulated ductile iron.
4. Backup rings shall meet the pressure class of the pipe.
5. Bolt sets shall conform to the requirements of Section 02500 – Buried Pipe Installation

E. Mechanical Connections

1. Mechanical connections may be used where indicated on the Contract Drawings.
2. Mechanical connections shall conform to the requirements of Section 15000 and shall be specifically approved for use by on HPDE pipe by the HDPE pipe manufacturer.
3. All mechanical connections shall be full restrained to prevent pipe pull-out at the rated pressure of the pipe.
4. Pipe stiffeners shall be used where recommended by the HDPE pipe manufacturer.

2.3 FITTINGS

A. Fittings shall be polyethylene fabricated fittings and shall meet the following requirements.

1. All fittings shall be either molded or fabricated in accordance with AWWA C906.
2. All fittings shall have the same SDR as the pipe they are used on.
3. All fittings shall be fabricated from the same polyethylene material as the pipe.
4. All fittings shall be fully pressure rated and meet requirements for AWWA C906.
5. Reinforced fittings (fiberglass wrapped for example) are not allowed.
6. All fittings shall have taper bored ends to meet adjoining pipe wall thickness.
7. All elbows shall be sweep elbows. For example, all 90 degree elbows shall be 5-segment elbows and all 45 degree elbows shall be 3-segment elbows.
8. All fittings shall be pressure tested to four times working pressure of pipe for five seconds or alternative back-bend test as provided for in AWWA C906.

B. Polyethylene flange adapters shall be made with sufficient through-bore length to be clamped in a butt-fusion machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to restrain the gasket against blow-out.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.
- B. Pipe shall be delivered in 40-foot lengths or longer but not longer than can be transported over highways. This is required to minimize field construction time and to maximize the control over the environmental conditions that affect the fusion processes and thereby the ultimate quality of the completed joint.

3.2 INSTALLATION

- A. Pipe sections with gouges or cuts deeper than 10% of the wall thickness shall be cut out and removed and replaced by the CONTRACTOR at no additional cost to the OWNER. Undamaged pipe portions shall be rejoined using butt-fusion joining methods.
- B. Butt Fusion and Socket Fusion Joining
 - 1. Clean joint surfaces: Prepare joint surfaces according to manufacturer's recommendations. Use devices to force pipes together with minimum open recess inside and outside and tightly seal joints. Avoid forces that could wedge apart and split ends.
 - 2. Do not pull or cramp joints without permission of ENGINEER.
 - 3. Remove unfittable pipes and replace with sound units.
- C. After bedding pipe, place and compact bedding between pipe and sides of trench. Compact bedding under lower half of pipe. Place and compact bedding as indicated and in conformance with Section 02200 – Earthwork.

3.3 TESTING

- A. General
 - 1. Inspect each pipe and fitting prior to fusion of the joints. Remove defective pipes from the site.
 - 2. Wall Uniformity Samples shall be obtained as described in Part 1.3 of this Section.
- B. Hydrostatic testing, including test pressure and duration, of the HDPE pipe shall be in accordance with the requirements of Section 02640 – Pipeline Testing and Disinfection and this Section.
- C. Allowances for expansion under test pressure for a 3-hour test duration is shown in the table below. Allowance only apply to the test phase and not to the initial filling and achieving equilibrium.

Nominal Pipe Size	Allowance of Expansion (gallons)

(inches)	per 100 feet of pipe)
2	0.19
4	0.4
6	0.9
8	1.5
10	2.1
12	3.4
14	4.2
16	5
18	6.5
20	8
24	13.3
30	19.2
36	
48	
54	
60	

END OF SECTION

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**SECTION 02595 – POLYVINYL CHLORIDE NON-PRESSURE PIPE,
RUBBER JOINTS (ASTM D3034 AND F679, MODIFIED)**

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all polyvinyl chloride (PVC) non-pressure pipe and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01300 Submittals, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.
 - 1. Material lists that describe all materials to be utilized.
 - 2. Design calculations for wall thickness or pressure class for all pipe whose thickness or pressure class is not specifically defined and for all restrained joint length requirements not specifically defined.
 - 3. Manufacturer's written Quality Assurance/Quality Control Program.
 - 4. Certified dimensional drawings of all valves, fittings and appurtenances.
- B. Samples: The Contractor shall submit to the Engineer for approval, samples of all the materials proposed for use on the Work. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions. All sampled submittals shall conform to the requirements in Section 01300 - Submittals.
- C. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:
 - 1. Sustained pressure test reports.
 - 2. Burst strength test reports.
 - 3. Physical and chemical properties for the material components of all pipe, specials and appurtenances.

4. Hydrostatic test reports for pipe and rubber gaskets, where applicable.
 5. Crushing test reports for samples taken from the center of full length sections of pipe.
 6. Flattening resistance, impact resistance and stiffness test reports.
 7. Rubber gasket tests, as applicable.
- D. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. All PVC pipe, in compliance with this Specification, shall be continuously and permanently marked with the manufacturer's name and code, pipe size, PVC minimum cell classification, pipe stiffness classification, pressure rating in psi, and ASTM designation where applicable.
- B. The manufacturer's code shall include the year, month, day, shift, plant and extruder of manufacture. This coding shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number and other information deemed necessary by the manufacturer.

2.2 PIPE

- A. All PVC pipe shall be joined by compression joints unless otherwise shown or specified and shall conform to the following requirements:
1. Polyvinyl chloride (PVC) shall conform to the requirements of ASTM D3034 or F679, as applicable, Class SDR 35. Material for PVC pipe shall conform to the

requirements of ASTM D1784 for Class 12454-B, 12454-C or 12364-C as defined therein. Maximum filter content shall be 10 percent.

2. Rubber gaskets or elastomeric seals for compression type joints for PVC pipe and fittings shall conform to the requirements of ASTM D3212 or ASTM F477 as applicable.

2.3 FITTINGS

- A. All fittings for PVC pipe shall conform to the requirements of ASTM D3034 or ASTM F679, as applicable. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.
- B. The strength class, stiffness or wall thickness of any fitting shall not be less than the strength class, stiffness or wall thickness of any adjoining pipe or of pipe of an equivalent size.

2.4 BEDDING MATERIAL

- A. Unless otherwise specified or shown, all material used for pipe bedding shall conform to the requirements for "Embedment Materials" as specified in ASTM D2321 and the requirements of Section 02200 - Earthwork.

2.5 FLEXIBLE COUPLINGS

- A. Flexible couplings shall be rubber, full-circle, clamp-on type conforming with ASTM C425 and provided with two stainless steel band screw clamps to secure the coupling tightly to entering and exiting pipes. All screw-clamp hardware shall be Type 316 stainless steel. Rubber material shall be suitable for sewage service.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.
- B. Storage: Pipe should be stored, if possible, at the job site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.2 INSTALLATION

- A. Installation shall conform to the requirements of ASTM D2321 and to the supplementary requirements specified herein. Wherever the provisions of this Section and the requirements of ASTM D2321 are in conflict, the more stringent provision shall apply.

3.3 LAYING PIPE

- A. The pipe shall be installed in accordance with the requirements of ASTM D2321 and as specified herein and shown and the sections shall be closely jointed to form a smooth flow line.
- B. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter not any other method that may fracture the pipe or will produce ragged, uneven edges.

3.4 FIELD JOINTING

- A. Each pipe compression type joint shall be joined with a lock-in rubber ring and ring groove that is designed to resist displacement during pipe installation.
- B. The ring and ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall then be forced into the ring to complete the joint.
- C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

3.5 ANCHOR BLOCKS

- A. Anchor blocks shall be installed in accordance with the details shown.

3.6 TESTING

- A. Mandrel testing: In addition to the requirements of Section 02640 – Pipeline Testing and Disinfection, all PVC gravity non-pressure pipe shall be tested for deflection and obstructions. The mandrel test shall be performed after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel, with a circular cross section having a diameter of at least 97 percent of the base inside diameter, as defined in ASTM F679, shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point, the pipe shall be repaired and retested.

END OF SECTION

**SECTION 02597 – POLYVINYL CHLORIDE PRESSURE PIPE, RUBBER JOINTS (AWWA
C900 AND C905, MODIFIED)**

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install all polyvinyl chloride (PVC) pressure pipe and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 02500 – Buried Pipe Installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The CONTRACTOR shall submit Shop Drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01300 - Submittals, Section 02500 – Buried Pipe Installation, the requirements of the referenced standards and the following supplemental requirements.
 - 1. Material lists that describe all materials to be utilized.
 - 2. Design calculations for wall thickness or pressure class for all pipe whose thickness or pressure class is not specifically defined and for all restrained joint length requirements not specifically defined.
 - 3. Manufacturer's written Quality Assurance/Control Program.
 - 4. Certified dimensional drawings of all valves, fittings, and appurtenances.
- B. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance to the ENGINEER guaranteeing that the pipe and other products or materials furnished hereunder is in compliance with the requirements of these Specifications, the reference standards and the following supplemental requirements:
 - 1. Sustained pressure test reports.
 - 2. Burst strength test reports.
 - 3. Physical and chemical properties for the material components of all pipe, specials and appurtenances.
 - 4. Hydrostatic test reports for pipe and rubber gaskets, where applicable.
 - 5. Rubber gasket tests, as applicable.

- C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR at no increased cost to the OWNER.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

- A. PVC pressure pipe shall conform to the applicable requirements of ANSI/AWWA C900 and C905 and the additional requirements specified herein.

2.2 PIPE DESIGN CRITERIA

- A. General: PVC pressure pipe shall be designed in accordance with the requirements of AWWA Manual M23, as applicable, and the supplemental requirements specified in this Section.
- B. Minimum Wall Thickness (DR): The minimum wall thickness DR for PVC pressure pipe shall be DR 18. Where service designation is for high pressure (150 psi up to 200 psi), minimum wall thickness DR shall be DR 14. The pipe pressure classification shall be derated for service temperature exceeding 77 degrees F as provided for in AWWA C900 and C905.
- C. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a minimum thickness (t) or dimension ratio (DR) in accordance with the above referenced AWWA Manual M23. The design pressure, unless noted otherwise, shall be the test pressure indicated in the pipe schedule in the Drawings.
- D. Determination of External Loads: In lieu of the equations specified in the above referenced AWWA Manual M23, the dead (earth) loads shall be computed using the following 2 equations for trench or embankment loading as applicable:

1. Trench Condition:

$$W_d = C_d W B_d^2$$

Where: W_d = Earth Load in pounds per linear foot
 C_d = Calculation Coefficient
 $K_u' = 0.13$
 $W = 145 \text{ lb/ft}^3$
 B_d = Trench width at top of pipe, feet

2. Positive Projecting Embankment Condition:

$$W_c = C_c w B_c^2$$

Where: W_c = Earth load in pounds per linear foot
 C_c = Calculation coefficient (based on $r_{sd}P$ of 0.75)
 $K_u = 0.19$
 $w = 145 \text{ lb/ft}^3$
 B_c = Outside diameter of pipe, feet

- E. Similarly, in lieu of the method specified in AWWA Manual M23, the truck live loads shall be determined using the method recommended by AASHTO - Standard Specifications for Highway Bridges. For depths of cover less than 10 feet HS-20 live loads shall be added to the earth loads to determine the total load. For depths of cover 3 feet or less, HS-20 live load plus impact shall be included.
- F. Deflection Control: The deflection of the pipe after installation shall not exceed 0.03 times the outside diameter. If the calculated deflection exceeds 0.03 times the outside diameter the pipe class shall be increased or the quality of the pipe zone backfill shall be improved to achieve a higher modulus of soil reaction, E' . For purposes of calculation, values of E' shall be 1000 psi. The deflection lag factor shall be 1.25.

2.3 PIPE

- A. The pipe shall be of the diameter and pressure class or DR specified or shown, shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. The dimensions and pressure classes for PVC pressure pipe shall conform to the requirements of AWWA C900 or C905 for cast iron pipe equivalent outside diameters.
- B. Additives and Fillers: Unless otherwise provided in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin). If requested by the ENGINEER, the additive and filler content shall be determined using the pyrolysis method as specified in ASTM D 2584.
- C. Joints: All joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling, both employing a rubber ring joint. The bell and coupling shall be the same or greater thickness as the pipe barrel. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors. Where shown or required, restrained joint pipe shall be ductile iron pipe cathodically protected in accordance with Section 16640 – Cathodic Protection. No restrained joint PVC pipe will be allowed.

2.4 FITTINGS

- A. Fittings shall be ductile iron and shall conform to the requirements of AWWA C110, Class 250. PVC pipe fittings shall be mechanical joint.
- B. All fittings shall be lined and coated in accordance with the requirements of Section 09960 – Protective Coatings.
- C. Each fitting shall be clearly labeled to identify its size and pressure class.
- D. Ductile iron pipe fittings shall be cathodically protected in accordance with Section 13115 – Cathodic Protection System.

2.5 COLOR

- A. PVC pipe with the service designations RW and 3W shall be purple in color. The purple PVC pipe shall be colored with pigment at the time of extrusion by the manufacturer utilizing a method in conformance with AWWA C900. The remaining services shall be the standard manufactured color for PVC pipe and shall not be purple in color.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All pipe specified under this Section shall be handled according to the provisions of Section 02500 – Buried Pipe Installation.
- B. Handling: Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.
- C. Storage: Pipe should be stored, if possible, at the job site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.2 INSTALLATION

- A. All laying, jointing, and testing for defects leakage shall be performed in the presence of the ENGINEER and shall be subject to approval before acceptance. All material found during the process to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the site of the work.
- B. Installation shall conform to the requirements of AWWA Manual M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements specified herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

- C. Piping and its installation shall be in accordance with Section 02500 – Buried Pipe Installation and Section 15000 – Piping, General.
- D. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.
- E. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.
- F. Pipe shall be cut by means of saws, power driven abrasive wheels or pipe cutters that shall produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander or abrasive disc.

3.3 SERVICE CONNECTIONS

- A. Service Connections: Direct tapping will not be permitted. Double strap stainless steel service clamps shall be used for all service connections. Service clamps shall have a bearing area of sufficient width along the axis of the pipe, so that the pipe will not be distorted when the saddle is made tight. An internal shell cutter shall be used to drill through the corporation stop to minimize PVC shavings, retain the coupon, and reduce stress. Single fluted shell cutters or twist drills are not acceptable. Lubricate the cutting and tapping edges of the tool with cutting lubricant. Make the cuts slowly and use the follower very lightly - do not force cutter through pipe wall. Shell cutter shall have sufficient throat depth to handle the heavy wall PVC pipe. Maximum outlet size permitted with service clamps or saddle is 2 inches.
- B. Tapping sleeves and valves shall be used for all outlet sizes greater than 2 inches in diameter. Tapping sleeves shall be assembled and installed in accordance with the manufacturer's recommendations.

3.4 CORROSION CONTROL

- A. Cathodic protection shall be provided for all metallic appurtenances (pipe restraints, fittings, saddles, etc.) in accordance with Section 13115 – Cathodic Protection Systems and the Drawings.

3.5 TESTING

- A. Mandrel Test: In addition to the requirements of Section 02640 Pipeline Testing and Disinfection, a mandrel test shall be performed on PVC pressure pipe smaller than 30-inches in diameter after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel with a circular cross section having a diameter of at least 97 percent of true average inside diameter shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point the pipe shall be repaired and retested.
- B. Deflection Test: In addition to the requirements of Section 02640 Pipeline Testing and Disinfection, pipe 30-inches in diameter and larger shall be checked for deflection after

backfilling and compacting but prior to final paving and prior to leakage testing. At every point within the pipe, the measured vertical inside diameter shall not be less than 97 percent of the average inside diameter.

END OF SECTION

SECTION 02600

IMPORTING SOILS AND FILL MATERIALS

PART 1 GENERAL

1.1 DESCRIPTION

- A. The work of this section consists of requirements and provisions that apply whenever the contractor and District determine that an import of soil or fill material is required in order meet these specifications.

1.2 RELATED WORK

- A. SECTION 02500 – Buried Pipeline Installation
- B. SECTION 02200 - Earthwork
- C. SECTION 02900 – Planting

PART 2 PRODUCTS

2.1 IMPORT FILL

- A. Import fill material, shall meet, but not be limited to, the following standards:
1. Shall be free of organic matter, trash, concrete rubble and other deleterious material.
 2. Shall be uncontaminated by regulated materials
- B. Import fill material shall conform to the following chemical requirements:

Constituent	Limit	Units
Inorganic Chemical Constituents		
Antimony	5	mg/kg
Arsenic	5.4	mg/kg
Barium	320	mg/kg
Beryllium	10	mg/kg
Cadmium	0.8	mg/kg
Chromium	140	mg/kg
Cobalt	21	mg/kg
Copper	49	mg/kg
Cyanide	2,500	mg/kg
Lead	160	mg/kg
Tetraethyl Lead	0.013	mg/kg
Mercury	0.4	mg/kg
Molybdenum	12	mg/kg
Nickel	110	mg/kg

Constituent	Limit	Units
Selenium	0.5	mg/kg
Silver	2	mg/kg
Thallium	1	mg/kg
Vanadium	74	mg/kg
Zinc	60	mg/kg
Semivolatile Organic Compounds		
Acenaphthene	30	mg/kg
Acenaphthylene	30	mg/kg
Anthracene	30	mg/kg
Benzo(a)anthracene	0.46	mg/kg
Benzo(a)pyrene	0.046	mg/kg
Benzo(b)fluoranthene	0.46	mg/kg
Benzo(g,h,i)perylene	30	mg/kg
Benzo(k)fluoranthene	4.6	mg/kg
BenzylAlcohol	1	mg/kg
Chrysene	30	mg/kg
Dibenzo(a,h)anthracene	0.046	mg/kg
Dibenzofuran	2,200	mg/kg
Fluoranthene	30	mg/kg
Fluorene	30	mg/kg
Indeno(1,2,3-cd)pyrene	0.46	mg/kg
2-Methylnaphthalene	30	mg/kg
4-Methylphenol(p-Cresol)	50	mg/kg
Naphthalene	30	mg/kg
n-Nitrosodiphenylamine	20	mg/kg
Pentachlorophenol	3	mg/kg
Phenanthrene	30	mg/kg
Phenol	30	mg/kg
Pyrene	30	mg/kg
VolatileOrganicCompounds		
Acetone	0.24	mg/kg
2-Butanone(MEK)	3.8	mg/kg
CarbonDisulfide	200	mg/kg
1,4-Dichlorobenzene	0.59	mg/kg
p-Isopropyltoluene(p-cymene)	130	mg/kg
MethyleneChloride	0.076	mg/kg
1,2,3-Trichlorobenzene	15	mg/kg
1,2,4-Trichlorobenzene	15	mg/kg
Trichlorofluoromethane	80	mg/kg
1,1,1-Trichloroethane	8	mg/kg
Polychlorinated Biphenols (PCBs), Pesticides, and Herbicides		
PCBs(Arochlor1254)	0.033	mg/kg
Aldrin	0.0039	mg/kg
alpha-BHC	0.062	mg/kg
beta-BHC	0.062	mg/kg
delta-BHC	0.062	mg/kg
Chlordane	0.009	mg/kg
2,4-D	0.025	mg/kg
Dicamba	0.01	mg/kg
4,4'-DDD	0.049	mg/kg
4,4'-DDE	0.098	mg/kg
4,4'-DDT	0.0082	mg/kg
Dieldrin	0.039	mg/kg
Endosulfan	1.1	mg/kg
Endosulfansulfate	1.1	mg/kg

Constituent	Limit	Units
Endrin	0.004	mg/kg
Endrin aldehyde	0.004	mg/kg
Endrin ketone	0.004	mg/kg
gamma-BHC(Lindane)	0.01	mg/kg
Heptachlor	0.017	mg/kg
Heptachlorepoide	0.017	mg/kg
Isodrin	0.0039	mg/kg
MCP	5	mg/kg
Methoxychlor	0.44	mg/kg
Petroleum Hydrocarbons and Constituents		
TPH(asdiesel)	100 ^(a)	mg/kg
TPH(asgasoline)	100 ^(a)	mg/kg
TPH(asfueloil/motoroil)	100 ^(a)	mg/kg
Benzene	0.005 ^(a)	mg/kg
Ethylbenzene	0.005 ^(a)	mg/kg
Toluene	0.005 ^(a)	mg/kg
TotalXylenes	0.005 ^(a)	mg/kg
Dioxins/Furans		
2,3,7,8-TCDD	8.2E-06	mg/kg

Notes:

(a)From California Regional Water Quality Control Board, San Francisco Bay Region Order No.R2-2003-0080

- C. All proposed testing of potential import material shall be consistent with testing requirements of The California Department of Toxic Substances Control, including the DTSC Fact Sheet, *Information Advisory, Clean Imported Fill Material*, October 2001.
- D. The following materials have been previously tested and are accepted by NPS for use under this contract without further chemical testing pursuant to this specification:

Source/Quarry Name	Address	Pre-approved product
Mark West Quarry	4611 Porter Creek Road Santa Rosa CA 95404	AB Rock (and products with similar size gradations)
Stony Point Quarry	7171 Stony Point Road Cotati CA	AB Rock (and products with similar size gradations)
San Rafael Quarry	1000 Point San Pedro Road San Rafael CA 94901	Drain Rock (greater than ¾"), Rip Rap
Broadmoor Landscape Supply	1350 El Camino Real South San Francisco, CA 94080	Soil (from Brisbane Quarry)

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor shall ensure that all environmental sampling work is conducted and supervised by individuals and/or a subcontract firm holding the appropriate and applicable technical and professional credentials and/or licenses required by the State of California as necessary.

- B. The Contractor shall ensure that any environmental sampling the contractor conducts follows EPA, California and American Society of Testing and Materials protocols and guidance
- C. Chemical testing of proposed import materials shall be conducted consistent with DTSC Soil Guidance cited in Section 2.1C.
- D. Material Testing
 - 1. A sampling plan will be prepared and submitted to the Construction Manager for approval prior to collection and analysis of any samples of proposed import materials for any materials not already listed as pre-approved.

END OF SECTION

SECTION 02620 – HYDRAULIC STRUCTURE TESTING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform all cleaning, flushing, and testing of all new or modified hydraulic structures and appurtenant piping, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval in accordance with the provisions of Section 01300 - Submittals. Also, the Contractor shall submit written notice a minimum of 72 hours before testing is to start.

PART 2 PRODUCTS

2.1 MATERIALS REQUIREMENTS

- A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

PART 3 EXECUTION

3.1 GENERAL

- A. Water for testing will be furnished by the Contractor as specified in Section 01500 – Construction Facilities and Temporary Controls; however, the Contractor shall make all necessary provisions for conveying the water from the source to the points of use.
- B. The Contractor shall be responsible for performing all work required by regulatory agencies, including, but not limited to, testing of the hydrostatic test water and obtaining all required permits for discharge of test water. The Contractor is notified that use of potable water for hydrostatic tests does not necessarily guarantee approval by regulatory agencies for discharge of hydrostatic test water into sanitary sewers or storm drains.
- C. All testing operations shall be performed in the presence of the Engineer.
- D. If industrial paint finishes or other protective coatings are to be applied to the interior surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.

- E. Release of water from structures, after testing has been completed, shall be in accordance with the testing plan submitted to and accepted by the Engineer and shall comply with all applicable laws and regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

- A. Prior to testing, all hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. All water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the structure or otherwise removed.

3.3 TESTING OF HYDRAULIC STRUCTURES

- A. General: Testing shall be performed prior to backfilling, except where otherwise acceptable to the Engineer. Testing shall not be performed sooner than 14 days after all portions of structure walls and associated roof systems have been completed. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 24 inches of depth per day. There shall be no damp spots or visible seepage/leakage on exterior walls of the hydraulic structure. A damp spot shall be defined as a spot having sufficient moisture to be transferred to a dry hand upon touching. All visible leakage shall be repaired.
- B. Leakage Test and Repairs: After the structure has been filled, the water loss leakage test shall be performed as follows: an initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. Should the structure fail to pass the test, the test shall be repeated for up to 3 additional 7-day test periods. If, at the end of 28 days, the structure still fails to pass the leakage test, the Contractor shall empty the structure as acceptable to the Engineer and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage. Any cracks shall be "vee'd" and sealed with polyurethane sealant in accordance with Section 03300 – Cast-In-Place Concrete. Any evidence of leakage shall be repaired. Following these operations, the Contractor shall again test the hydraulic structure. The structure will not be accepted as completed until the water loss leakage test is passed and all visible leakage repaired.

3.4 TESTING OF APPURTENANT PIPING

- A. Piping appurtenant to hydraulic structures shall be tested as specified in Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 02640 – PIPELINE TESTING AND DISINFECTION

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall perform all cleaning, flushing, and testing, of all pipelines, and disinfection of all pipelines for potable water, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval in accordance with the provisions of Section 01300 - Submittals. Also, the CONTRACTOR shall submit written notice a minimum of 72 hours before testing is to start.

PART 2 PRODUCTS

2.1 MATERIALS REQUIREMENTS

- A. Temporary valves, bulkheads, or other water control equipment and materials shall be as determined by the CONTRACTOR subject to the ENGINEER's review. No materials shall be used which would be injurious to the construction or its future function.
- B. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301; sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300. Liquid chlorine shall be used only (1) in combination with appropriate gas flow chlorinators and ejectors; (2) under the direct supervision of an experienced technician; and (3) when appropriate safety practices are observed.
- C. Test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the CONTRACTOR's expense prior to the leakage test, if required by the ENGINEER.

PART 3 EXECUTION

3.1 GENERAL

- A. Water for testing will be furnished by the CONTRACTOR as specified in Section 01500 – Construction Facilities and Temporary Controls. The CONTRACTOR shall make all necessary provisions for conveying the water from the source to the points of use.

- B. The CONTRACTOR shall be responsible for performing all work required by regulatory agencies, including, but not limited to, testing of the hydrostatic test water and obtaining all required permits for discharge of test water. The CONTRACTOR is notified that use of potable water for hydrostatic tests does not necessarily guarantee approval by regulatory agencies for discharge of hydrostatic test water into sanitary sewers or storm drains.
- C. All testing operations shall be performed in the presence of the ENGINEER.
- D. Conduct the tests on piping after the piping has been completely installed, including all backfill, supports, hangers, and anchors.
- E. Pipelines conveying the following fluids shall be disinfected following hydraulic testing. All disinfection shall be done in the presence of the ENGINEER.
 - 1. 1W (potable water)
- F. Disinfection operations shall be scheduled by the CONTRACTOR as late as possible during the Contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the OWNER. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner. Results of the bacteriological testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.
- G. Release of water from pipeline, after testing and disinfecting (as applicable) have been completed, shall be in accordance with the testing plan submitted to and accepted by the ENGINEER and shall comply with all applicable laws and regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

- A. Prior to hydrostatic testing, all new pipelines shall be flushed or blown out as appropriate.

3.3 TESTING OF NON-PRESSURE PIPELINES

- A. General: Unless otherwise specified, all process drains, storm drain lines and other miscellaneous drain piping shall be tested for exfiltration or infiltration, according to State and Local standards and as specified herein. Where the two specifications are in conflict, the more stringent of the two shall be followed. All manhole(s)/inlet(s) shall be tested for leakage, as specified. Manhole(s)/inlet(s) shall be tested prior to backfill placement, whereas all pipes shall be backfilled prior to testing. All leakage tests shall be completed and approved prior to placing permanent surfacing. When leakage or infiltration exceeds the amount allowed by the Specifications, the CONTRACTOR, at its expense, shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests.
- B. Leakage Tests: Unless otherwise specified or shown, storm drainage and miscellaneous drainage systems shall be tested for leakage as follows:
 - 1. For Pipe 24 inches or less in diameter, where difference in elevation between inverts of adjacent manhole(s)/inlet(s) is 10 feet or less; water exfiltration test or

water infiltration test as approved. The ENGINEER may allow substitution of an air pressure test for the water exfiltration test.

2. For Pipe 24 inches or less in diameter, where difference in elevation between inverts of adjacent manhole(s)/inlet(s) is greater than 10 feet; air pressure test or water infiltration test, or as approved.
 3. For Pipe greater than 24 inches in diameter; air pressure test or water infiltration test, or as approved.
- C. Water Exfiltration Test: Each section of pipe shall be tested between successive manhole(s)/inlet(s) by closing the lower end of the pipeline to be tested and the inlet pipe of the upper manhole/inlet with stoppers. The pipe and manhole/inlet shall be filled with water to a point 4 feet above the centerline of the sewer (except as limited by finish grade at manhole/inlet) depth at the center of the upper manhole/inlet; or if groundwater is present, 4 feet above the average adjacent groundwater level, whichever is higher.

The allowable leakage shall be computed by the formula:

$$E = 0.000012 LD (H)^{1/2}$$

Where:

E = Allowable leakage in gallons per minute of pipeline tested.

L = Length of pipeline tested, including laterals, in feet.

D = Internal diameter of the pipe in inches.

H = Difference in elevation between the water surface in the upper manhole/inlet and the centerline of the pipe at the lower manhole/inlet; or if groundwater is present above the centerline of the pipe in the lower manhole/inlet, the difference in elevation between the water surface in the upper manhole/inlet and the groundwater at the lower manhole/inlet.

- D. Water Infiltration Test: If, in the opinion of the ENGINEER, excessive groundwater is encountered in the construction of a section of the pipeline, the exfiltration test for leakage shall not be used. The end of the pipeline at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration. The infiltration into each individual reach of pipeline between adjoining manhole(s)/inlet(s) shall not exceed that allowed by the formula in Subsection 3.3C, where H is the difference in the elevation between the groundwater surface and the invert of the sewer at the downstream manhole/inlet. Unless otherwise specified, infiltration will be measured by the CONTRACTOR using measuring devices approved by the ENGINEER.
- E. Air Pressure Test: The CONTRACTOR shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the ENGINEER. The CONTRACTOR may conduct an initial air test of the pipeline after densification of the backfill but, in the case of sanitary sewer testing, prior to installation of the building drains. Such tests will be considered to be for the CONTRACTOR's convenience and need not be performed in the presence of the ENGINEER. Each section of pipeline shall be tested between successive manhole(s)/inlet(s) by plugging and bracing all

openings in the main pipeline and the upper ends of all outlets and building drains. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

1. The final leakage test of the pipeline and outlet branches shall be conducted in the presence of the ENGINEER and shall be performed in accordance with the procedures defined in ANSI/ASTM C828.
2. At the CONTRACTOR's option, joints may be air tested individually, joint by joint, with the use of specialized equipment. The CONTRACTOR shall submit its joint testing procedure for the ENGINEER's review and demonstrate, to the ENGINEER's satisfaction, that the testing procedure will adequately evaluate the pipe system being tested, prior to actual testing. Prior to each test, the pipe at the joint shall be wetted with water. The maximum test pressure shall be 3.0 psi. The minimum allowable pressure drop shall be 1.0 psi over a 30-second test period.

F. Water Pressure Test: Preparatory to testing, the section of the pipeline to be tested shall be filled with water and placed under a slight pressure for at least 48 hours. The pipeline shall then be brought up to the test pressure specified and maintained on the section under test for a period of not less than 4 hours.

1. Accurate means shall be provided for measuring the quantity of water required to maintain full pressure on the line for the test period, which volume shall not exceed:

$$L = \frac{CN D (P)^{1/2}}{1850}$$

Where:

L = Maximum allowable leakage in gallons per hour for the section of pipeline tested

N = Number of joints in length tested

D = Diameter of pipe in inches

P = Test pressure in psi

C = 1.0 for non-pressure polyethylene or PVC pipe

C = 3.0 for reinforced concrete pressure pipe with rubber joints, non-cylinder type

G. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the ENGINEER as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the CONTRACTOR.

3.4 TESTING OF MANHOLES AND INLETS

- A. All manhole(s)/inlet(s) shall be hydrostatically tested for leakage after installation, but prior to being backfilled. Prior to hydrostatic testing, all manhole(s)/inlet(s) shall be visually inspected for leaks. All leaks or cracks shall be repaired by the CONTRACTOR, prior to hydrostatic testing, to the satisfaction of the ENGINEER.
- B. All pipes entering the manhole/inlet shall be sealed at a point outside the manhole/inlet walls so as to include testing of the pipe/manhole joints.
- C. The manhole/inlet shall be filled with water to a level 2 inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the manhole/inlet shall be refilled and the water level shall be checked. The water level shall again be checked after a period of 4 hours. If the water level is reduced by more than 1/4-inch, the leakage shall be considered excessive, and the CONTRACTOR shall be required to make all necessary repairs and retest the manhole/inlet. The exterior of the manhole/inlet shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole/inlet shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the ENGINEER regardless of the volume of water lost.

3.5 TESTING OF PRESSURE PIPELINES

- A. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing new valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. Testing shall not be performed against existing system closed valves. The CONTRACTOR shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. Care shall be taken to see that all air vents are open during filling.
- B. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 14 days have elapsed after the thrust blocking is installed. If high-early strength cement is used for thrust blocking, the time may be reduced to 3 days. When testing PVC or HDPE piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the PVC or HDPE pipe to accommodate swelling/absorption. Refill with makeup water before test.
- C. Hydrostatic testing. Expel all air from the piping system prior to testing and apply and maintain the test pressure hereinafter specified by means of a hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for the specified time, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. Pressure tests shall be made by filling the system for two hours continuously.
- D. The pipeline shall be filled at a rate that shall not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof

has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will, to allow the pipe and water to achieve temperature equilibrium and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.

1. Repairs of defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated after defects have been eliminated at no additional cost to the Owner.
- E. The pipeline being tested will be equipped with a relief valve to permit pressure relief if the pressure exceeds 20 to 25 percent above the required test pressure to prevent pipeline failure.
- F. Pressure Gauge(s): Provide sufficient number of calibrated pressure gauges capable of measuring pressure 50 percent over intended test pressure. Location of pressure gauges shall be determined by the CONTRACTOR and submitted with the pressure test plan, subject to approval by the ENGINEER.
- G. Pressure gauges and relief valves shall be checked for accuracy to the satisfaction of the ENGINEER before being used during actual testing of pipeline.
- H. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for yard piping shall be as shown or specified on the Piping Schedule measured at the lowest point of the pipeline section being tested. All visible leaks shall be repaired in a manner acceptable to the ENGINEER.
- I. Allowable Leakage:
1. If not specified in the piping schedule or in these Specifications, the maximum allowable leakage for pressure pipelines shall be 10 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-ft or greater lengths between joints and with rubber-gasketed joints and 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20-ft or less lengths between joints and with rubber-gasketed joints.
 2. Pipe with welded joints shall have no leakage.
 3. Exposed Pipe: Leakage shall be zero at the test pressure hereinafter specified throughout the duration for exposed piping. Conduct testing and maintain the testing pressure for two hours continuously.
 4. In the case of pipelines that fail to pass the prescribed leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines.
- J. The pipes shall be drained after hydrostatic testing, unless otherwise permitted by the ENGINEER.
- K. Pneumatic Testing

1. General: Pneumatic testing shall be performed on pipes as indicated on the piping schedule. Air used for testing shall be dry and oil-free. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
2. Procedure: Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connection, examine for leakage. Correct visible leaks and repeat preliminary test until visible leaks are corrected. Gradually increase pressure in system to half of the test pressure. Test pressures are specified in the Pipe Schedule. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached. Maintain pneumatic test pressure for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage. Correct visible leakage and retest as specified.

3.6 TEST RECORDS

- A. The Contractors shall submit a sample test record form for review by the Construction Manager in accordance with Section 01300. The CONTRACTOR shall record and maintain all tests performed and shall submit test records to the Construction Manager within 24-hour of test completion. Test records shall include as a minimum:
 1. Date and time of beginning and end of pipeline testing.
 2. Identification of pipeline being tested.
 3. Test fluid.
 4. Test pressure.
 5. Ambient temperature.
 6. Pressure gauge reading taken during the test.
 7. Quantities of make-up water added during the test.
 8. Signatures of test technician, CONTRACTOR's representative who witnessed the test, and the Owner representative who witnessed the test.

3.7 DISINFECTION OF PIPELINES

- A. General: The CONTRACTOR shall disinfect all potable water pipelines in accordance with the requirements of ANSI/AWWA C651 using the Continuous-Feed Method as modified herein.
- B. Chlorination: A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 50 mg/l. A backflow prevention device shall be installed on the water supply line to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

- C. Retention Period: Chlorinated water shall be retained in the pipeline long enough to destroy all non-spore-forming bacteria. This period shall be at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 25 mg/l.
- D. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily-chlorinated water.
- E. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water.
- F. Bacteriological Testing: After final flushing and before the pipeline is placed in service, a sample, or samples shall be collected by the CONTRACTOR from the end of the line, and shall be tested for bacteriological quality in accordance with the requirements of the State Department of Health or other appropriate regulatory agency. For this purpose the pipe shall be re-filled with fresh potable water and left for a period of 24 hours before any sample is collected. Should the initial disinfection treatment fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

3.8 CONNECTIONS TO EXISTING SYSTEM

- A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

3.9 FACTORY TESTING

- A. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The CONTRACTOR shall perform all tests at no additional cost to the Owner.

END OF SECTION

SECTION 02700 – PRECAST TRENCH DRAINS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install the precast polymer concrete trench drain, including all components and sub-components necessary to install the system as specified herein and in accordance with the requirements of the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Shop drawings and laying diagrams shall be completed by the manufacturer and submitted to the Engineer for approval in accordance with Section 01300 Submittals.
- B. Submit manufacturer's catalog data including: materials of construction, dimensions, spacing and construction of trench system, chemical resistance and installation guide.
- C. Certifications: The Contractor shall furnish a certified affidavit of compliance to the Engineer guaranteeing that the products or materials furnished hereunder is in compliance with the requirements of these Specifications.

PART 2 PRODUCTS

2.1 GENERAL

- A. The drain, grating and accessories in traffic areas shall be designed to withstand H-20 loading. Trench drains located in process areas where access is restricted to pedestrians shall be designed for a loading of 100 pounds per square foot. Presloped concrete drain components shall have a minimum average internal slope of 0.5%. Top of drain shall not be sloped. Drain and grating shall be installed flush with concrete surfaces. Drain shall have a capacity for a flow of 0.1 cfs minimum

2.2 TRENCH DRAIN CHANNELS

- A. Trench drain channels shall be precast polymer concrete formed with a matched metal tooling utilizing a vinyl ester resin coating. Channels shall interlock fully and evenly with adjoining channels.
- B. The interior surface of the grated line drain, below the level of the frame and grate and associated connections, shall be smooth. Grated line drain channel sections shall be manufactured of monolithic polymer concrete with no side extensions
- C. Each channel shall have horizontal anchoring ribs located along the bottom of the channel as a means of mechanical engagement into the adjacent concrete.
- D. The channel shall be supplied with a discharge outlet for a six inch drain line at the low point of the sloped trench, as shown on the Drawings.

2.3 CHANNEL GRATES

- A. Channel grates shall bear evenly on the channel edges. Grates in traffic areas shall be able to withstand H-20 loading. Grates not in traffic areas shall be heavy duty non-

traffic grates, able to withstand a minimum of 100 pounds per square foot. Lock down bolts and bars shall be provided and installed to hold the gratings firmly in place. All grates shall be made of a chemical resistant material or have a long wearing, manufacturer applied, chemical resistant coating. Grates shall fit into the channels without rocking.

- B. Grated line drain frames and grates shall be manufactured of ductile iron conforming to the provisions in Section 05500 – Miscellaneous Metals. The frames and grates shall be hot dip galvanized. Bolts, nuts, frame anchors, and other connecting hardware shall conform to the provisions in Section 05500 – Miscellaneous Metals.

2.4 MANUFACTURERS

- A. All components of the system shall be from a single manufacturer.
- B. Manufacturer, or equal, shall be:
 - 1. Quazite Polycast
 - 2. ABT, Inc.
 - 3. ACO Polymer Products, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Products specified under this Section shall be stored according to the manufacturer's recommendations.
- B. All products found to be damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

3.2 INSTALLATION

- A. The presloped drain system shall be installed in accordance with manufacturer's recommendations and approved shop drawings.
- B. Excavation and backfill shall conform to the provisions in Section 02200 – Earthwork.
- C. Excavation shall provide a minimum of 6" channel and bedding concrete on the sides and base of the trench drain.
- D. Channel placement shall begin at the deepest end (tie in point).
- E. Grated line drains shall be connected to new or existing drainage facilities as shown on the Drawings.
- F. Channel ends are to be interlocked with surfaces reasonably flush and even. All joints shall be sealed according to manufacturer's recommendations and the Drawings. Joints are to be fully anchored using chair support. The channel shall be held in place during installation by an installation chair placed at the joint of each channel. The chairs shall allow alignment of channels, mechanically lock channels together, prevent floating during placement of concrete, and provide additional anchoring with the concrete slab.

- G. The frame or grate of the grated line drain shall not extend above the level of the surrounding concrete work.
- H. After adjoining concrete flat work has been placed and finished, all channels and grates shall be thoroughly cleaned and grates reinstalled and secured.

END OF SECTION

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SECTION 02810 - IRRIGATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work in this section consists of furnishing, layout and installing an irrigation system complete, including certification of irrigation system installation as required by the State of California Model Water Ordinance described herein.
- B. Related work specified elsewhere includes:
 - 1. Section 02200, EARTHWORK.
 - 2. Section 02900, PLANTING.

1.2 CALIFORNIA MODEL WATER EFFICIENT LANDSCAPE ORDINANCE REQUIREMENTS

- A. Contractor shall be familiar with and follow the State of California Model Water Ordinance, California Code of Regulations, Title 23 Waters, Division 2, Department of Water Resources, Chapter 2.7. Also, the Contractor is responsible to follow all local water ordinances.
- B. Pursuant to the requirements of the California Model Water Efficient Landscape Ordinance, the Contractor shall submit a Certification of Installation to the Local Jurisdiction /water purveyor as described in the construction documents and these specifications. Certification shall at a minimum include the following documents:

PART 1. Project Information Sheet

PART 2. Certification of Installation according to the landscape documentation package.

PART 3. Irrigation Scheduling and Controller Programming

PART 4. Schedule of Landscape and Irrigation

PART 5. Landscape Irrigation Audit Report

PART 6. Soil Management/Analysis Report with verifying implementation, see Planting Specification for analysis requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Specifications: Follow manufacturer's current printed specifications and drawings in all cases where the manufacturers of articles used in the Contract furnish directions covering points not specified or shown in the drawings.
- B. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality,

higher standard, or larger size than is required by the above codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.

C. References, Codes and Standards:

1. AB 325 and 1881 State of California Model Water Efficient Landscape Ordinance, California Code of Regulations Title 23.
2. California Environmental Quality Act (CEQA)
3. Water Use Classification of Landscape Species (WUCOLS).
4. American Society of Irrigation Consultants (ASIC) Design Guidelines.
5. California Landscape Standards, California Landscape Contractors Association, (CLCA) Sacramento, California.
6. CAL-OSHA, title 8, Subchapter 4-Construction Safety Orders and Subchapter 7-General Industry Safety Orders.
7. California Electric Code.
8. California Plumbing Code (UPC) published by the Association of Western Plumbing Officials.
9. NFPA 24, Section 10.4, Depth of Cover.
10. Underwriters Laboratories (UL): Electrical wiring, controls, motors and devices, UL listed and so labeled.
11. American Society of Testing Materials (ASTM).

D. Furnish without extra charge any additional material and labor when required by the compliance with all above mentioned codes and regulations, though the work be not mentioned in these specifications or shown on the drawings.

E. Experience: Assign a full-time employee to the job as supervisor for the duration of the Contract with a certified landscape technician, irrigation certification through CLCA or minimum of four (4) years experience in landscape irrigation installation.

F. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work to be accomplished to perform the task in a competent, efficient manner acceptable to the Owner's Representative.

G. Explanation of Drawings:

1. Due to the scale of the Drawings, it is not possible to indicate all piping offsets, fittings, sleeves, etc., which may be required. Carefully investigate the conditions affected all of the work and plan accordingly, and furnish all required fittings. Install system in such a manner to avoid conflicts with planting, utilities and architectural features.
2. Do not install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in arc dimensions exist that might not have been considered in engineering. Bring such obstruction or differences to the attention of the Owner's Representative. Notify and coordinate irrigation Work with applicable contractors for location and installation of piping and sleeves through or under walls, pavement and structures. In the event this notification is not given, the Contractor shall assume full responsibility for any revision necessary.

H. Trench Interference with Tree Root Systems:

1. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.
 2. Mechanical Trenching is not allowed within dripline of existing trees to be protected except as approved by Landscape Architect.
- I. Coordinate plant locations with emitter locations.
 1. Adjust plant locations in relation to the subsurface emitter s as required to ensure that the plant roots receive the proper amount of water in order for it to thrive.
 2. Coordinate planting and irrigation and provide hand watering of emitter irrigated and drip irrigated areas as required to maintain moist root zones until end of plant establishment period.

1.4 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

- A. The Drawings show, if applicable, existing above and below grade structures and utilities that are known to the Owner. Locate known existing installations before proceeding with construction operations that may cause damage to such installations. Existing installations shall be kept in service where possible and damage to them shall be repaired with no adjustment of Contract Sum. Verify with Owner if As Built drawings are available.
- B. If other structures or utilities are encountered, request Owner's Representative to provide direction on how to proceed with the Work. If a structure or utility is damaged, take appropriate action to ensure the safety of persons and property.
- C. Verify location of existing irrigation systems to be removed and/or replaced. Maintain any existing systems as required by the Drawings and Specifications, including temporary retention of systems necessary to maintain existing on site and adjacent planting.

1.5 SUBMITTALS, in accordance with Section 01300

- A. Materials List:
 1. Submit required copies of the cut sheets and a complete list of materials proposed for installation, along with any proposed substitutions clearly identified and obtain the Owner Representative's written approval thereof before proceeding. Use only accepted materials and items of equipment.
 2. List all materials by manufacturer's name and model number.
 3. Submit to Local Water Purveyor with copy to the Owner Certification of Installation as required by the State of California Model Water Ordinance.
- B. Substitutions:
 1. If the Contractor desires to substitute a product, he shall list each item and note it as a "substitution" and provide the following information:
 - a. Descriptive information describing its similarities to the specified product.

2. If the product is approved and, in the opinion of the Owner's Representative, the substituted product does not perform as well as the specified product, the Contractor shall replace it with the specified product at no additional cost to the Owner.
- C. Operations and Maintenance Manuals:
1. Prior to the final acceptance of the irrigation system, furnish three (3) individually bound Operation and Maintenance Manuals to the Owner's Representative for use by the Owner. The manuals shall contain complete enlarged drawings, diagrams and spare parts lists of all equipment installed showing manufacturer's name and address. In addition, each Service Manual shall contain the following:
 - a. Index sheet indicating the Contractor's name, address and phone number.
 - b. Copy of the Landscape Irrigation Audit
 - c. Copy of the 12-month irrigation schedule and estimate of annual water consumption
 - d. Copies of equipment warranties and certificates.
 - e. List of equipment with names, addresses and telephone numbers of all local manufacturer representatives.
 - f. Complete operating and maintenance instructions in sufficient detail to permit operating personnel to understand, operate and maintain all equipment.
 - g. Parts list of all equipment such as controllers, valves, solenoids and heads.
- D. Record Drawings:
1. Dimension the location of the following items from two (2) permanent points of reference such as building corners, sidewalks, road intersections, etc.:
 - a. Connection to existing water lines/meter.
 - b. Gate valves.
 - c. Routing of pressure lines (a dimension at least every 100 feet and as required to identify all changes in direction and location).
 - d. Remote control valves.
 - e. Routing of control valves.
 - f. Quick coupling valves.
 - g. All sleeve locations.
 - h. Routing of all control wiring.
 - i. Include all invert elevations below 12".
 2. Deliver a reproducible record drawing to the Owner's Representative within seven (7) working days before the date of final review. Delivery of the record drawings shall not relieve the Contractor of the responsibility of furnishing required information in the future.
- E. Maintenance Material - supply the following tools to the Owner:
1. Three (3) sets of specialized tools required for removing, disassembling and adjusting each type of irrigation head, valve or other equipment supplied on this project.
 2. Two (2) keys for each type of equipment enclosure.
 3. Two (2) keys for each type of valve (including square type key for valves larger than 2")
 4. Two (2) quick-coupler keys and matching hose swivels for each type of quick-coupling valve installed.
 5. All lock keys shall be keyed alike.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Furnish and deliver materials in manufacturer's packaging, bearing original legible labeling.
- B. The Contractor is cautioned to exercise care in handling, loading, unloading, and storing PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of the pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented, cracked, or otherwise damaged shall be discarded and, if installed, shall be replaced with new piping.

1.7 TRENCH INTERFERENCE WITH TREE ROOT SYSTEMS

- A. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.

1.8 SEQUENCING AND SCHEDULING

- A. Acceptance: Do not install main line trenching prior to acceptance by Owner's Representative of rough grades completed under another Section.
- B. Coordination: Coordinate with the work of other sections to insure the following sequence of events:
 - 1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving and through walls prior to placement of those materials.
 - 2. Bubbler Heads: Install after placement of tree, but prior to backfill with planter soil mix.
 - 3. On-Structure Equipment: Install piping and risers after waterproofing is accepted.
 - 4. Coordinate work schedule with Owner to avoid disruption of landscape maintenance of existing landscaping.
 - 5. Install piping prior to soil preparation (planting soil amendment installation).

1.9 WARRANTY, per Section 01740

- A. In addition to manufacturer's guarantees and warranties, work shall be warranted for one (1) year from date of final acceptance against defects in material, equipment and workmanship. Warranty shall also cover repair of damage to any part of the premises resulting from leaks or other defects in materials, equipment and workmanship to the satisfaction of the Owner.
- B. Include a copy of the warranty form in the Operation and Maintenance Manual.

1.10 OPERATION

- A. Routine: Inspect and adjust all spray heads and control valves including raising or lowering of spray head heights to accommodate plant growth and weather conditions.
- B. System Failure: Perform all repairs within one (1) operating period. Replacements to match removed products and materials in all respects. Report promptly all damage not resulting from Contractor's operations. Repair all damage caused by Contractor at no expense to Owner.
- C. Climate Change: Set and program automatic controllers in response to seasonal requirements and requirements of newly planted materials.

PART 2 - PRODUCTS

2.1 PIPE

- A. Pressure Main Line Pipe and Fittings: All PVC fittings shall bear the manufacturer's trademark name, material designation, size, applicable I.P.S. schedule and NSF seal of approval.
- B. All main line pipe shall be solvent welded and shall be schedule 40 unless shown otherwise on the Drawings.
- C. All main line pipe shall be solvent welded.
 - 1. PVC Pressure Rated Pipe: ASTM D2241 NSF approved Type I, Grade I, solvent welded PVC with an appropriate standard dimension ratio (S.D.R.).
 - 2. PVC Scheduled Pipe: ASTM D1785 NSF approved, Type I,
 - 3. Grade I, solvent welded PVC.
 - 4. PVC Solvent-weld Fittings: ASTM D2466 Schedule 40, 1-2, II-I NSF approved.
 - 5. Solvent Cement and Primer for PVC solvent-weld pipe and fittings: Type and installation methods prescribed by the manufacturer.
 - 6. Connections between Main Lines and RCVs: Schedule 80 PVC (threaded both ends) nipples and fittings unless required otherwise by local jurisdiction.
- D. All lateral line pipe shall be solvent welded and shall be schedule 40 unless shown otherwise on the Drawings.

2.2 REMOTE CONTROL VALVE: As shown on Drawings and with the following minimum requirements:

- A. Remote control valves shall be those normally manufactured for irrigation systems and shall have a slow, consistent speed of closure through entire closing operation, including last portion. To ensure this, the effective diaphragm working area/valve seating opening ratio must be a minimum 3 to 1.
- B. Shall be mechanically self-cleaning to help prevent diaphragm or solenoid port plugging. To ensure this, the flush rod should be tapered to vary the size of the port opening as the diaphragm raises and lowers, thus allowing trapped material to escape.

Rod is to be finished with a serrated surface to help scrub trapped material out.
Screens not acceptable.

- C. Shall have removable valve seat so valve can be repaired without removal from irrigation line.
- D. Shall have ability to operate manually without the use of wrenches or special keys.
- E. Shall have one-piece solenoid that attaches directly to valve without shunts or clips that can be lost.
- F. Shall have cross top handle to adjust maximum travel of diaphragm to allow "tuning" of valve and closure.
- G. Shall be battery powered.

2.3 CONTROL VALVE AT QUICK COUPLER: Assembled with the following minimum requirements.

- A. Brass Wye manifold with a ball valve shutoff on each outlet. Wye manifold must be able to attached to existing exterior hose bibs, typically a ¾" coupling.
- B. Combination valve and clock/timer unit.
 - 1. Unit shall operate without electrical power - either battery operated or utilizing a mechanical mechanism (wind-up timer).
 - 2. Clock should be programmable for a cycle of up to 6 hours. It should have the ability to easily and quickly change watering schedules due to changes in weather.
 - 3. Unit must be able to be attached to one of the ¾" outlets on the wye manifold.

2.4 BOX FOR REMOTE CONTROL VALVE

- A. Rectangular plastic valve box - Ametek, Carson, Christy, Rain Bird or accepted equal with black color lid. Box body shall have knock outs. Do not saw cut body. The minimum size box is as shown on Drawings. Increase box size as required to fit. Valve box lids are to indicate the controller letter and station number of valve as accepted by Owner's Representative. Also refer herein to required polyurethane tag at valve solenoid control wire under Control Wires. Locate the identification in center of the lid. Provide separate box for each valve. Provide H/20 Loading concrete boxes with bolt-down concrete lids for all valves that occur in paved areas.

2.5 TREE BUBBLER HEADS

- A. Shall be Rain Bird RWS-M, Root Watering System, or approved equal.

2.6 QUICK COUPLER VALVES

- A. Quick coupler valves shall be as listed on the Drawings with 10" diameter box and lid similar to isolation valve box described below.

- B. Quick coupler valves shall be equipped with black covers.

2.7 ISOLATION VALVE

- A. Valves 3 inches and smaller: 125 lb. WSP bronze gate valve with screw-in bonnet, non-rising stem and solid wedge disc, NIBCO T-113 K, or approved equal. Valves shall be line size.
- B. Valves larger than 2": shall have square nut stem and o-ring connections for key operation.

2.8 DRIP IRRIGATION

- A. Drip Manifold
- B. Pressure Regulator: Preset at 30 psi outlet pressure, ¾" female threaded inlet and outlet, by RainBird, Toro or equal.
- C. Emitters: Xeri-Bug (XB Series) by RainBird, Toro EZ Drip Series, or equal.
- D. Flexible PVC: ASTM D2287 algae-resistant flexible PVC as recommended by manufacturer of Drip Emitters.
- E. Drip tubing: Conform to A. S. A. E. standards for minimum inside diameter and wall thickness, Minimum 2% carbon black, Salco ¾" AR Drip PVC flexible drip hose, or equal.
- F. ¾" Y-filter, 200 mesh.
- G. Toro DL 2000 Air/Vacuum Relief Valves and In-line Spring Check Valves.
- H. ¾" manual PVC ball valve with extra 3' of hose coiled in valve box.
- I. Drip system in accordance with "RainBird Xerigation Low-Volume Landscape Irrigation Design Manual" and as shown on the drawings as required for a complete working system.

2.9 BOX FOR ISOLATION VALVE

- A. 10" diameter plastic, Ametek, Brooks, Christy, Rain Bird with bolt down lid marked "irrigation," or accepted equal. Avoid locating valve in paved areas. Provide H/20 Loading concrete box with bolt-down concrete lid if valve is located in paved area. Obtain location approval by Owner's Representative.
- B. Isolation valves shall be equipped with black covers.

2.10 BACKFLOW PREVENTION DEVICE

- A. As required by Code and as shown on Drawings. Verify with Owner if Anti-freeze Jacket is required and provide as required.
- B. Riser assemblies from main line burial depth to backflow preventers shall be Schedule 40 brass pipe.
- C. All metallic pipe and fittings installed below grade shall be painted with two coats of Koppers #50 Bitumastic, or approved equal. Pipes may be wrapped with an approved asphaltic tape in lieu of the liquid-applied coating.
- D. Backflow preventer shall receive a minimum 6 inch thick concrete coordinated to fit backflow preventer enclosure as shown and as accepted by the Landscape Architect.
- E. Shall be 1-1/2" reduced pressure backflow preventer with check valves and pressure regulator, Lead-free. Wilkins 975xL2 Lead Free size 1-1/2", or approved equal.

2.11 BACKFLOW PREVENTION DEVICE ENCLOSURE

- A. "Smooth Touch" enclosure without sharp edges, by Strong Box, available from V.I.T., Escondido, CA (800) 729-1314 or equal. Coordinate size of enclosure with plumbing for minimum clearance and size. Enclosure to include concrete footing with hasp and staple to receive padlock. Padlock N.I.C.

2.12 CONDUIT/SLEEVES

- A. Sleeving shall be Schedule 40 PVC pipe sleeves and a minimum of two times the aggregate diameter of all pipes contained within the sleeve. Provide vertical sweep for all electrical conduit on each side of hardscape and terminate ends at 12" minimum depth and 12" from hardscape surface.

2.13 Y-STRAINER

- A. "Y"-Strainer upstream of remote control valves, Brass, 100 mesh.

2.14 RCV IDENTIFICATION TAGS: Plastic or brass tags with valve number, approximately 2" by 2" with number imprinted, as accepted by Owner.

2.15 MISCELLANEOUS INSTALLATION MATERIALS

- A. Solvent Cement and Primers for Solvent-weld Joints: Make and type approved by manufacturer(s) of pipe and fittings. Maintain cement proper consistency throughout use.
- B. Pipe and Joint Compound: Permatex: Do not use on sprinkler inlet port.

2.16 MISCELLANEOUS EQUIPMENT/ACCESSORIES

- A. Concrete for equipment pads: Poured-in-place Class A concrete per Section 90 of the Caltrans Standard Specifications.
- B. Sleeves and Conduits: See Drawings.
- C. Key(s) for Quick-Coupling Valves:
 - 1. Type: Same manufacturer as Quick-Coupling Valve.

2.26 OTHER EQUIPMENT: As shown on Drawings and required for a fully functional irrigation system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Sleeves and Conduits: Verify that all installed sleeving and conduits are undisturbed and are free of defects or errors introduced by the work of other sections.
- B. Water Meter/Water Pressure: Test and verify that existing water pressure is the minimum pressure at maximum system g.p.m. to operate the irrigation system as indicated on the drawings.
- C. Stub-outs: Verify that all stub-outs to be provided under another contract are correctly sized, located and installed as noted on Drawings.
- D. Notification: Submit written notification to Owner's Representative within ten (10) working days of above inspections describing all acceptable and non-acceptable site conditions.

3.2 TRENCH LAYOUT/INTERFERENCE WITH TREE ROOT SYSTEMS

- A. Prior to trenching, layout main and lateral line locations within Drip Line of trees and review locations with Owner's Representative. Relocate any lines that may interfere with existing root systems to avoid or reduce damage to root systems as accepted by Owner's Representative.

3.3 CONNECTIONS TO SERVICES

- A. Provide and coordinate connection to water meter.
- B. Provide and coordinate connection of irrigation controller to electrical power source.

3.4 INSTALLATION

- A. Install irrigation system components in accordance with this Section, with the Drawings, with the manufacturer's recommendations, and with established industry standards. The Contractor shall do nothing that may jeopardize any manufacturer warranty.
- B. Conduits and Sleeves:
 - 1. Coordination: Provide conduits and sleeves and coordinate installation with other trades.
 - 2. Extent: Install conduits and sleeves where control wires and pipes pass under paving or through walls as shown on Drawings. Extend twelve inches (12") beyond edges of paving and walls and cap ends until ready for use.
- C. Excavating and Trenching:
 - 1. Pipe Layout: Layout pipe lines within Spread of Tree Branches as described above in Section 3.2, TRENCH INTERFERENCE WITH TREE ROOT SYSTEMS.
- D. Dig trenches wide enough to allow a minimum of three inches (3") between parallel pipe lines. Pipeline Assembly:
 - 1. Install pipe and fittings in accordance with manufacturer's current printed Specifications.
 - 2. Clean all pipes and fittings of dirt, scale and moisture before assembly.
 - 3. Solvent-welded Joints for PVC Pipes:
 - a. Solvents: Use solvents and methods specified by pipe manufacturer.
 - b. Curing Period: Minimum of one (1) hour before applying any external stress on the piping and at least 24 hours before placing the joint under water pressure.
 - 4. Threaded Joints for Plastic Pipes:
 - a. Use Permatex on all threaded PVC fittings except sprinkler heads and quick coupler valve ACME threads.
 - b. Joining: Use strap-type friction wrench only. Do not use metal-jawed wrench. Assemble finger tight plus one or two turns.
 - 5. Laying of Pipe:
 - a. Bedding On-grade: Remove from trench all rocks or clods. Bed pipe in at least 2 inches of soil excavated from trench. Backfill on all sides of piping to provide a uniform bearing.
 - b. Snaking: Snake pipe from side to side of trench bottom to allow for expansion and contraction. Minimum allowance for snaking is one (1) additional foot per 100 ft. of pipe.
 - c. Moisture Restrictions: Do not lay PVC pipe when there is water in the trench. Do not assemble PVC pipe unless the pipe is dry.
- E. Control Valves:
 - 1. Install in valve boxes where shown on Drawings and group together where practical. Install box flush with finish grade, not necessarily level. If valve occurs in drainage swale, relocate out of drainage swale as approved by Owner's Representative.

2. Where two or more valves are installed adjacent to each other, provide at least six inches (6") separation. Align boxes in a row, perpendicular with pavement edge.
 3. Permanently mark valve box lid with 2" black valve number and controller letter or with numbered metal tag inside box as approved by Owner's Representative.
 4. Refer to control wiring for required spare wire in each valve box.
- F. Install "Y"-Strainer upstream of remote control valves at backflow preventer with two pressure gauges, one upstream and one downstream of each strainer/filter.
- G. Head Installation:
1. Bubblers:
 - a. Coordinate installation with planting contractor to insure timely and proper placement of heads at new planting.
- H. Drip Irrigation:
1. Install system in accordance with "RainBird Landscape Irrigation Design and Specifications Xerigation Products and Details" or equal and as shown on the Drawings as required for a complete working system.
 2. Install Toro DL 2000 Air/Vacuum Relief Valves at high points in system.
 3. Install manual PVC ball valve with extra 3' of hose coiled in valve box at end(s) of collector laterals so that entire system will flush and be free of dirt and debris.
- I. Closing of Pipe and Flushing of Lines:
1. Capping: Cap or plug all openings as soon as lines have been installed to prevent entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
- J. Detection Wire and Warning Tape:
1. Install a bare # 12 copper wire or greater on top of the PVC supply line for the purpose of possible future mine detection search.
 2. Install a continuous PVC irrigation mainline warning tape 12" above the supply line.
- K. RCV IDENTIFICATION TAGS: Install in remote control valve box as recommended by manufacturer and as accepted by Owner's Representative.

3.5 MISCELLANEOUS EQUIPMENT

- A. Install miscellaneous equipment with concrete footings, brackets, etc., as required and as recommended by manufacturer.

3.6 FIELD QUALITY CONTROL

- A. Testing of Irrigation System:
1. Make hydrostatic tests with risers capped when welded PVC joints have cured at least 24 hours. Center load piping with backfill to prevent pipe from moving under pressure. Keep all couplings and fittings exposed.
 2. Install two (2) pressure gauges at opposite ends of main line system. Pump system up to a minimum of 125 psi the day preceding the scheduled test and verify that pressure is holding. Inspect system early following day and

immediately notify Owner's Representative if the test confirmation must be postponed.

3. Apply continuous static water pressure of 125 psi in accordance with Caltrans Standard Specifications Section 20-5.03H, except after a drop in pressure (5 psi maximum), then the pressure must stabilize and remain stable for a one (1) hour minimum period before acceptance of the test.
4. Leaks detected during tests shall be repaired and test repeated until system passes tests at no additional cost to Owner.

B. Irrigation Audit Report with Certificate of Completion

1. Per the requirements of the California Model Water Efficient Landscape Ordinance, the Contractor shall perform an irrigation audit and provide a report with certificate of completion to the local agency that may include, but is not limited to: inspection, system tune-up, system test with distribution uniformity, reporting overspray or run off that causes overland flow, and preparation of an irrigation schedule. Irrigation audits shall be conducted by a CLIA Certified landscape Irrigation Auditor by the Irrigation Association. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

C. Adjustment of the System:

1. Flush and adjust all heads for optimum performance and to prevent overspray onto walks, roadways and buildings. Set all heads perpendicular to finished grades unless otherwise noted on the drawings.
2. When the landscape irrigation system is completed and before planting, perform a coverage test in the presence of the Owner's Representative to determine if the water coverage for planting areas is adequate.
3. Test controllers individually in the presence of the Owner's Representative and the Landscape Architect. Demonstrate that all control valves operate electronically. Provide vehicles and radio equipment as necessary to expedite this process.
4. Demonstrate to Owner's Representative that irrigation scheduling programmed into controller is adequate for plant requirements without causing runoff, and that scheduling capacities of controller are utilized.

3.7 IRRIGATION SCHEDULING AND CONTROLLER PROGRAMMING

- A. Per the requirements of the California Model Water Efficient Landscape Ordinance All irrigation schedules and programs shall be developed, managed and evaluated to utilize the minimum amount of water required to maintain plant health.
- B. Irrigation controller Scheduling and Programming Parameters to be conducted by a CLCA Certified Irrigation manager and submitted to the local agency as part of the Certificate of Completion.
- C. Parameters used to set the automatic controller shall be developed for each of the following:
 1. Plant establishment period
 2. Established landscape period
 3. Temporary irrigated area (if applicable)

- D. Each irrigation schedule shall consider for each station all of the following that apply:
 - 1. Irrigation interval (days between irrigation)
 - 2. Irrigation run times (hours or minutes per irrigation event to avoid runoff)
 - 3. Number of cycle starts required for each irrigation event to avoid runoff
 - 4. Amount of applied water scheduled to be applied on a monthly basis
 - 5. Application rate setting
 - 6. Root depth setting
 - 7. Plant type setting
 - 8. Soil type
 - 9. Slope factor setting
 - 10. Shade factor setting
 - 11. Irrigation uniformity or efficiency setting
- E. Total annual applied water shall be less than or equal to Maximum Applied Water Allowance (MAWA). Actual irrigation schedules shall be regulated by automatic irrigation controllers using current reference evapotranspiration data (CIMIS or soil moisture sensor data).

3.8 BACKFILL AND COMPACTING

- A. General: After system is operating and required tests and reviews have been made, backfill excavations and trenches with clean soil, free of debris.
- B. Backfill for All Trenches: Regardless of the type of pipe covered, compact to minimum 95% density under pavements and 85% under planted areas.
- C. Finishing: Dress off areas to finish grades. Re-dress any areas which subsequently settle.
- D. Owner's testing agency will test backfill compaction in areas under paving.

3.9 MAINTENANCE

- A. The entire irrigation system shall be under full automatic operation for a period of 2 days prior to any planting.
- B. The Owner's Representative reserves the right to waive or shorten the operation period.
- C. Maintain/repair system for full duration of plant maintenance period.

3.10 REVIEWS PRIOR TO ACCEPTANCE

- A. Notify the Owner's Representative in advance for the following reviews, according to the time indicated:
 - 1. Supply line pressure test and control wire installation - 72 hours.
 - 2. Coverage and controller test - 72 hours.
 - 3. Final review - 7 days.

- B. No reviews will commence without record drawings, without completing previously noted corrections, or without preparing the system for review.

3.11 FINAL REVIEW AND CLEANUP

- A. Operate each system in its entirety for the Owner's Representative at time of final review. Any items deemed not acceptable by the Owner's Representative shall be reworked to the complete satisfaction of the Owner's Representative.
- B. Provide evidence to the Owner's Representative that the Owner has received all accessories and equipment as required before final review can occur.
- C. Final acceptance and start of warranty period will occur no earlier than the end of the plant maintenance period.
- D. For time of final review, Contractor shall arrange a meeting with the Owner's maintenance personnel to demonstrate the operation of the irrigation systems automatically in order to verify acceptance and to familiarize the maintenance personnel with the system and recommended programming.

WATER EFFICIENT LANDSCAPE WORKSHEET

Hydrozone*	Zone or Valve	Irrigation Method**	Area (Sq. Ft.)	% of Landscape Area
LW	A1	B	90	4.51%
LW	A2	D	618	30.96%
LW	A3	D	457	22.90%
LW	A4	D	291	14.58%
MW	A5	D	540	27.05%
	TOTAL:		1,996	100%

*Hydrozone

HW = High Water Use Plants
 MW = Moderate Water Use Plants
 LW = Low Water Use Plants

**Irrigation Method

S = Spray
 R = Rotor
 B = Bubbler

Maximum Applied Water Allowance:

MAWA = (ET_o) (0.62) [(0.7 x LA) + (0.3 x SLA)]
 MAWA = (25.85) (0.62) [(0.7 x 1,527) + (0.3 x 0)]
MAWA = 22,393 gallons per year

Estimated Total Water Use:

ETWU = (ET_o) (0.62) (PF x HA / IE + SLA)
 ETWU = (25.85) (0.62) ((1,572 x 0.3) / 0.085 + 0)

ETWU = 14,345 gallons per year

*See Construction documents for hydrozone plan.

END OF SECTION

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SECTION 02822
VINYL BONDED CHAIN LINK FENCING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete chain link fencing and gates as shown on the drawings and as specified.
- B. Related requirement specifications elsewhere:
 - 1. Section 02200, EARTHWORK
 - 2. Section 03300, CAST-IN- PLACE CONCRETE

1.2 QUALITY ASSURANCE

- A. Reference Standards
 - 1. State of California Department of Transportation (Caltrans), "Standard Specifications."
 - 2. Manufacturer's recommendations and specifications.
 - 3. ASTM A36 Standard Specification for Carbon Structural Steel
 - 4. ASTM A392 Standard Specification for Zinc-Coated Steel Chain-Link Fabric
 - 5. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-dip Galvanized Coatings
 - 6. ASTM A817 Standard Specification for Metallic-Coated Steel Wire for Chain Link Fence Fabric and Marcellled Tension Wire
 - 7. ASTM A824 Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link
 - 8. ASTM F552 Standard Terminology Relating to Chain Link Fencing
 - 9. ASTM F567 Standard Practice for Installation of Chain Link Fence
 - 10. ASTM F626 Standard Specification for Fence Fittings
 - 11. ASTM F668 Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain Link Fence Fabric
 - 12. ASTM F900 Standard Specification for Industrial and Commercial Swing Gates
 - 13. ASTM F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework
 - 14. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
 - 15. ASTM F1664 Standard Specification for Polyvinyl Chloride (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used With Chain Link Fence
 - 16. WLG2445 Chain Link Fence Manufacturers Institute, Chain Link Fence Wind Load Guide for the Selection of Line Posts and Line Post Spacing
 - 17. Local City or County Codes, whichever is more stringent.

1.3 SUBMITTALS: Per Section 01300

- A. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
- B. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.

- C. Submit sample of each fabric size and color if requested.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Company having manufacturing facilities in the United States with 5 years experience specializing in manufacturing of chain link fence products.
- B. Fence contractor: Contractor having 5 years experience installing similar projects in accordance with ASTM F567.
- C. Single source: To ensure system integrity obtain the chain link system, framework, fabric, fittings, gates and accessories from a single source

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Anchor Fence/Master Halco Inc., Baltimore MD (800) 229-5615 (specified); Boundary Fence & Railing Systems, Richmond Hill, NY (800) 628-8928; or Approved Equal.
- B. Manufacturer: Company shall have manufacturing facilities in the United States with a minimum 5 years experience specializing in manufacturing of chain link fence products.

2.2 FENCE SYSTEMS

- A. CHAIN LINK FENCE: Round Schedule 40 vinyl coated galvanized steel frame with concrete post footings, round rail at top and at bottom, and 9-gauge 2" mesh, vinyl coated galvanized chain link fabric. All rods, bars, bands, clips, bolts, tension wire, and other fittings shall be vinyl coated.

2.3 MATERIALS

- A. Conform to Caltrans Standard Specifications, Section 80, except as required otherwise herein:
 - 1. Fabric: Hot-dipped galvanized after weaving, conforming to ASTM A116-88. Tensile strength of fabric shall be 80,000 psi minimum. Fabric shall be knuckled top and bottom, single width fabric to full height of fence. 9-gauge wire size plus vinyl fused-bonded color coating. Vinyl bonded fabric shall be fused-bonded with a PVC coating of 7 to 12 MILS (.007" to .012") per ASTM- F668 Class 2B.
 - 2. Color of chain link fabric per ASTM F934 Black.
 - 3. Steel pipe: All fence frame posts, rails, braces, shall be round pipe ASTM F1043 Group IA, ASTM F1083 standard weight schedule 40 hot-dip galvanized pipe having a zinc coating of 1.8 oz/ft² (550 g/m²) on the outside and 1.8 oz/ft² (550 g/m²) on the inside surface.
 - 4. Exterior of galvanized pipe to have F1043 PVC thermally fused color coating, minimum thickness 10 mils (0.254 mm).
 - 5. All fittings to be PVC thermally fused color coated having a minimum thickness of 0.006" (0.152 mm) per ASTM F626. PVC color to match fabric and framework. Moveable parts, nuts and bolts to be field coated with PVC liquid touch up after installation. Provide approved fused-bonded vinyl finish pivots and latch with

eyes for padlocking (padlock N.I.C.). Provide fused-bonded vinyl finish cane bolt at both leaves of gate.

6. Truss rod assembly: Fused-bonded vinyl finish galvanized steel minimum 5/16" diameter truss rod with pressed steel tightener, in accordance with ASTM F626
7. Post caps: ASTM F626 galvanized pressed steel, malleable iron, or aluminum alloy weather tight closure cap for tubular posts with fused-bonded vinyl finish. Provide one cap for each post. When top rail is specified provide line post loop tops to secure top rail.
8. Tension wire: Poly Vinyl Chloride (PVC) coated metallic coated steel tension wire per ASTM F 1664, 7 gauge steel core wire, 0.177", PVC coating class and color to match chain link fabric
9. Rail ends: Galvanized pressed steel per ASTM F626, for connection of rails to post using a brace band.
10. Top rail sleeves: 7" (178 mm) galvanized steel sleeve per ASTM F626. If expansion and contraction of the rail is of concern add a 0.137" wire diameter by 1.80" long expansion spring between the adjoining rails]
11. Wire ties: 9 gauge (0.148") galvanized steel wire for attachment of fabric to line posts and rails. Pre-formed hog ring ties to be 9 gauge (0.148") galvanized steel or aluminum for attachment of fabric to tension wire. Tie wire and hog rings PVC coated and in compliance with ASTM F626. Color to match fabric color.
12. Concrete: Minimum 28 day compressive strength of 3,000 psi.

B. Fence Post Schedule:

FENCE HEIGHT	END & CORNER POSTS		LINE POSTS			
	POST SIZE (O.D.)	FOOTING DEPTH & DIA.	POST SIZE (O.D.)	FOOTING DEPTH & DIA.	HORIZONTAL RAIL (O.D.)	MAXIMUM POST SPACING
6'	2 1/2" 3.65 lb/ft	10" dia. 30" deep	2" 2.72 lb/ft	10" dia. 30" deep	1 5/8" 2.27 lb/ft	10'-0" o.c.

- C. Above post footing sizes indicate a post bury to a minus 4 inches from bottom of footing. Where center rails are required, provide braces and trusts top and bottom panels.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. Ensure property lines and legal boundaries of work are clearly established.
- B. Survey of fence location to be provided by general contractor.
- C. Verify areas to receive fencing are completed to final grade.

3.2 FENCE FABRICATION AND ERECTION: Shall be in accordance with Caltrans Standard Specification Section 80, except as otherwise specified herein:

- A. Post Installation: Set posts in undisturbed or compacted soil, evenly spaced, plumb and true to lines with top line uniform in concrete to depths herein specified. End, corner, pull and gate posts to be braced with same material as top rail and trussed to line posts with 3/8" rods and tighteners. Line posts shall be evenly spaced 10' or less as specified. Top rail shall pass through line post tops and form a continuous brace within each stretch and be securely fastened to terminal posts. Splices in top rail shall be made with couplings at approximately 20' spacing. Set each post in 3,000 psi concrete footing sized in accordance with above Fence Schedule.
- B. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- C. Bracing: Install horizontal brace and truss assembly at mid-height or above for fences 6' and over at each fabric connection to the terminal post. The diagonal truss rod is installed at the point where the brace rail is attached to the terminal post and diagonally down to the bottom of the adjacent line post. Place the truss rod in tension by adjusting the turnbuckle
- D. Except as required otherwise, set top of concrete footing flush with grade and trowel smooth to slope away from post to drain. Post to extend to 4" from bottom of concrete footing. Allow concrete footings to cure 5 days before erection of fabric.
- E. Tension wire: Install tension wires so that it will be located 4" up from bottom the fabric. If top rail is not required, install the tension wire so that it will be located 4" down from the top of the fabric. Stretch and install tension wire before installing the chain link fabric and attach it to each post using wire ties.
- F. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces.
 - 1. Remove all metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
 - 3. Apply 2 coats of custom finish paint matching fence color if fence is painted.

3.3 RAILS:

- A. Make splices at top rails with couplings at approximately every 20'. Coupling shall produce a continuous brace of railing from end to end of each stretch of fence. Every fifth coupling in a stretch shall be fitted with a heavy spring to allow for expansion and contraction of rail. Rigidly clamp rails to end and corner post with appropriate fittings. Clamp mid-rail and bottom rail at each post using rail end or line rail clamps. Stretch all fabric tight, free from sags and bulges.

3.4 CHAIN LINK FABRIC ATTACHMENT

- A. Fabric: Install fabric on security side, pull fabric taut; thread the tension bar through fabric and attach to terminal posts with tension bands spaced maximum of 14" on center and attach so that fabric remains in tension after pulling force is released. Install fabric so that it is 2" +/- 1" above finish grade.

- B. Secure fabric using wire ties to line posts at 14" on center and to rails and braces 24" on center, and to the tension wire using hog rings 24" on center. Tie wire shall be secured to the fabric by wrapping it two 360 degree turns around the chain link wire pickets. Cut off any excess wire and bend back so as not to protrude so as to avoid injury if a pedestrian may come in contact with the fence.

3.5 CLEANING: Per Section 01700

- A. Clean up area adjacent to fence line from debris and unused material created by fence installation. Remove any concrete splash from fence posts.

END OF SECTION

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SECTION 02870 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install all site furnishings shown on drawings and specified in accordance with the manufacturer's instructions and as shown on the drawings and as specified.
- B. Related requirement specifications elsewhere:
 - 1. Section 03300, CAST-IN- PLACE CONCRETE
 - 2. Section 02900, PLANTING

1.2 REFERENCES

- A. Perform work in accordance with all applicable laws, codes and regulations required by the City and the State of California.
- B. Manufacturer's Instructions:
 - 1. Where required in the Specifications that materials, products, processes, equipment or the like to be installed or applied in accordance with manufacturer's instructions, directions or specifications, or words to this effect, it shall be constructed to mean that said application or installation shall be in strict accordance with printed instructions furnished by the manufacturer of the material for use under conditions similar to those at the job site.
 - 2. All site furnishings shall be anchored or otherwise secured to prevent movement, unless stated otherwise. Provide concrete footings, corrosion resistant clips, etc. as accepted by the Owner's Representative.
- C. Reference Standards:
 - 1. State of California, Business and Transportation Agency, Department of Transportation: "Standard Specifications."
 - 2. Manufacturers' specifications and recommendations.

1.3 COORDINATION

- A. Coordinate items of other trades. Contractor shall be responsible for the proper installation of all accessories embedded in concrete and for the provision of connections, holes, openings, etc., necessary to the execution of the work of the trades.

1.4 SUBMITTALS: Section 01300

- A. Picnic Table, including required leveling spacers.

PART 2 - MATERIALS

2.1 PICNIC TABLES

- A. Model: ADA Picnic Table #TF3578, with Full Bench #TF3570 and Half Bench #TF3593, Direct embedment with threaded inserts, Contractor to submit color samples; manufacturer: Wausau Made, Rio Vista, CA 94571 (707) 507-9610.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install manufactured items in accordance with the manufacturer's instruction and as shown in the drawings and as specified herein.
- B. Perform all work in accordance with all applicable laws, codes and regulations required by State of California and the City of Sausalito.
- C. Set all work true and square, plumb and level.
- D. Place washer under the head and nut of bolts where same bear on wood, except head of carriage bolt. Drill bolt holes same diameter as bolt.
- E. Size bolts to fit flush with nuts. Countersink nuts and bolts as detailed.
- F. Hammers with scored faces shall not be used in nailing.
- G. Supply all miscellaneous metal units and install as specified herein under the Sections entitled "Miscellaneous Metalwork" and "Galvanizing." Hot-dip galvanize all metal fastenings, angles, etc., after complete fabrication.
- H. Galvanized metal that is cut, damaged or modified after fabrication shall be immediately painted with Zinc-rich paint to prevent rusting.
- I. Touch up paint any damaged surfaces to match original finish as accepted by Owner's Representative.
- J. Set site furniture level.
- K. Transport, store and handle precast units and manufactured items in a manner to avoid hairline cracks, staining or other damage. Store units free of the ground and protected from mud or rain splashes. Cover units, secure covers firmly, and protect the units from dust, dirt or other staining material.

3.2 PICNIC TABLES

- A. Install level and in accordance with the manufacturer's instruction and as shown.

3.3 CLEANUP, per Section 01700

END OF SECTION

SECTION 02900 - PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide planting work and planting maintenance complete as shown on the drawings and as specified including staking and layout of the landscaping and soil sampling as required by the State of California Model Water Ordinance.
- B. Related work specified elsewhere includes:
 - 1. Section 02100, SITE PREP & PLANT PROTECTION
 - 2. Section 02200, EARTHWORK
 - 3. Section 02810, IRRIGATION

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Ordinances and Regulations: All local, municipal and state laws, codes and regulations governing or relating to all portions of this work are hereby incorporated into and made a part of these Specifications. Anything contained in these Specifications shall not be construed to conflict with any of the above codes, regulations or requirements of the same. However, when these Specifications and Drawings call for or describe materials, workmanship or construction of a better quality, higher standard than is required by the above mentioned codes and regulations, the provisions of these Specifications and Drawings shall take precedence. Furnish without extra charge additional materials and labor required to comply with above rules and regulations.
 - 2. Contractor shall be familiar with and follow the State of California Model Water Ordinance, California Code of Regulations, Title 23 Waters, Division 2, Department of Water Resources, Chapter 2.7. Also, the Contractor is responsible to follow all local water ordinances and the Soil Management/Analysis Report with verifying implementation.
 - 3. "Sunset Western Garden Book," Lane Publishing Co., Menlo Park, California; current edition.
 - 4. "American Standards for Nursery Stock," American Association of Nurseryman, 230 Southern Building, Washington, D.C. 20005.
 - 5. Alameda Countywide Clean Water Program (ACCWP) or member agency having jurisdiction over the project work.
 - 6. US Composting Council Compost analysis Program (CAP)
 - 7. Test Methods for the Evaluation of Composting and Compost (TMECC)
 - 8. International Society of Arboriculture, Guide for Plant Appraisal, latest version.
 - 9. United States Composting Council (USCC) Seal of Testing Assurance (STA) program.
 - 10. TMECC: Refers to "Test Methods for the Examination of Composting and Compost," published by the United States Department of Agriculture and the United States Compost Council (USCC).
 - 11. Manufacturer's recommendations.

B. Qualifications:

1. Experience: Assign a full-time employee to the job as foreman for the duration of the Contract who is certified landscape technician, certification through CLCA or minimum of four (4) years experience in landscape installation and maintenance supervision, with experience or training in turf management, entomology, pest control, soils, fertilizers and plant identification.
2. Labor Force: Provide a landscape installation and maintenance force thoroughly familiar with, and trained in, the work to be accomplished to perform the task in a competent, efficient manner acceptable to the Owner.

C. Requirements:

1. Supervision: The foreman shall directly supervise the work force at all times and be present during the entire installation. Notify Owner's Representative of all changes in supervision.
2. Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and a labor force uniformly dressed in a manner satisfactory to Owner's Representative.
3. Planting soils and organic amendments shall meet the AACWP requirement for the stormwater treatment measures used with this project work.

D. Plant Material Standards

1. Quality and Size of Plants: Conform to the State of California Grading Code of Nursery Stock, No. 1 grade and American Standards for Nursery Stock," American Association of Nurseryman. Use only nursery-grown stock which is free from insect pests and diseases.
2. Comply with federal and state laws requiring inspection for plant diseases and infestations. Submit inspection certificates required by law with each shipment of plants, and deliver certificates to the Owner. Obtain clearance from the County Agricultural Commissioner as required by law, before planting plants delivered from outside the County in which planted.

E. Soil and Soil Amendment Testing and Analysis:

1. Soils Testing Agency: Soil and Plant Laboratory, Inc., 1101 Winchester Blvd., Suite G-173, San Jose, CA 95128, Tel. (408) 727-0330; or Root Zone Associates, P.O. Box 18911, San Jose, CA 95118; Tel. (408) 264-7024, or approved equal.
2. All soils and organic soil amendments shall be submitted and tested by an accredited soils analyst. A standard soil analysis report shall identify sample source and include chemical analysis, fertility, agricultural suitability, and infiltration rates for soils. The report shall include all major nutrients, pH, salinity, boron, sodium, micronutrients, copper, zinc, manganese and iron, adsorption rate, organic content, soil texture and particle sizes. The report shall also include recommendations for modification of the soil(s) for agricultural suitability and compliance with the specified requirements, ordinances and regulations noted herein.
3. Upon approval of the soils report by the Owner's Representative, the recommendations in the report shall become a part of the Specifications and the quantities of soil amendment, fertilizer and other additives shall be adjusted to conform with the report at no additional cost to the owner. Request Testing Laboratory to send one copy of test results directly to Owner's Representative and one copy to the Owner.

F. Coordinate plant locations with irrigation emitter locations.

1. Adjust plant locations in relation to the subsurface emitter s as required to ensure that the plant roots receive the proper amount of water in order for it to thrive.
 2. Coordinate planting and irrigation and provide hand watering of emitter irrigated and drip irrigated areas as required to maintain moist root zones throughout plant establishment period.
- G. Damage from Deer, Rodents, Insects and Disease
1. Investigate planting for signs of damage from Deer, Rodents, Insects and Disease and provide repellents, barriers, or treatment and/or replacement upon discovery. Replace all damaged plants as described below in PLANTING ESTABLISHMENT MAINTENANCE.
- H. Mitigation of Lime Treatment of Site Soil.
1. If site work includes Lime Treatment of the site soil, the Contractor shall remove and replace the treated soil in all planting areas with approved imported planting soil and insure that the planting areas drain. If planting areas fail to properly percolate and drain, provide subsurface drainage structures as accepted by the Owner's Representative. Refer to PART 3 - EXECUTION for mitigation of the lime treated soil areas.

1.3 SUBMITTALS, per Section 01300

- A. Submit to the Owner's Representative, Manufacturer's current catalog cuts and technical data sheets of the following:
1. Fertilizers
 2. Iron Sulfate
 3. Tree and plant Ties /Support/Guying Materials
 4. Filter Fabric
 5. Permeable Backfill (Filter Rock): Also include 1-pint sample.
 6. Erosion Control Netting
- B. Plants and Seeding Samples: Submit following planting samples along with certificates of compliance / analytical data from suppliers for degree of compliance and recommendations:
1. Plants: Submit typical sample of each plant variety, or entire plant quantity to site for approval by Owner's Representative.
 2. Certificates of compliance for Hydroseed Mixes, Mulch and Tackifier for Erosion Control Seeding.
 3. Plant Photographs: Prior to shipping plants, provide color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery. Review and acceptance of any or all of the photographs does not signify that those plants are acceptable, and until the plants are inspected by the Owner's Representative on site will acceptance of the plants be determined.
- C. Soil Amendment and Mulch Sample and Analysis Reports:

1. Organic (Soil) Amendment(s): Submit 1-pint sample with certificate of compliance / analytical data Sheet. For Composted Organic Amendment, include STA certification.
 2. Organic Mulch: Submit 1-pint sample with source and list of ingredients.
 3. Organic Soil Amendment Delivery Receipts
- D. Planting Soil(s): Submit 1 pint samples along with Laboratory certificates of compliance / analytical data sheet and recommendations, including but not limited to the required samples listed below. The sample submitted for testing shall be from the supplier's current soil source and dated less than 6 months prior to installation. State the name and location of the supply source. Upon approval of the Laboratory's recommendations by the Owner's Representative, the recommendations in the report shall become a part of the Specifications:
1. Imported Planting Soil: For planter pockets
- E. Organic Soil Amendments Delivery Receipts
1. Provide delivery receipts for quantities of organic soil amendments delivered to the site.

1.4 PROJECT/SITE CONDITIONS

- A. Site Visit: At beginning of work, visit and walk the site with the Owner's Representative to clarify scope of work and understand existing project/site conditions.
- B. Protection of Plants from Deer: Contractor shall be responsible for protection of all planting from deer as described in Part 3- Execution.

1.5 WARRANTY AND REPLACEMENT, per Section 01740

- A. Pre-Emergence Weed Killer: Warrant the work against weed growth for a period of four (4) months after application.
- B. Warrant all plants and planting to be in a healthy, thriving condition until the end of the maintenance period, and deciduous trees, shrubs and vines beyond that time until active growth is evident.
- C. Replace all dead and damaged plants and plants not in a vigorous condition immediately upon discovery and as directed by the Owner's Representative at Contractor's expense. Install replacement plants before the final acceptance at the size specified.
- D. Warrant all plant material for a period of one year after final acceptance of the maintenance period against plant materials with defects at the time of installation.
- E. Warrant plant installation and maintenance by Contractor against defects for a period of one year.

PART 2 - PRODUCTS

2.1 PLANTS

- A. Plant the variety, quantity and size indicated. The total quantity tabulated on the drawings are considered approximate and furnished for convenience only. Contractor shall perform his/her own plant quantity calculations and shall provide all plants shown on the Drawings. If plants are shown on the Drawings but are not identified, Contractor shall provide plants of similar size and variety to nearby identified plants at no additional cost to the Owner.
- B. Measure trees and shrubs with branches in normal position. Height and spread dimensions indicated refer to the main body of the plant, and not from branch tip to tip.
- C. Tag plants of the type or name indicated and in accordance with the standard practice recommended by the American Association of Nurserymen.
- D. Install healthy, shapely and well rooted plants with no evidence of having been root-bound, restricted or deformed.
- E. Ensure that the plants arrive at the site in proper condition for successful growth. Protect plants in transit from windburn and sunburn. Protect and maintain plants on site by proper storage and watering.
- F. Substitutions will not be permitted, except as follows:
 - 1. If proof is submitted to the Owner's Representative that any plant specified is not obtainable, a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price.
 - 2. Substantiate and submit proof of plant availability in writing to the Owner's Representative within 10 days after the effective date of Notice to Proceed.
- G. Tree Form: Trees shall have a symmetrical form as typical for the species/cultivar and growth form.
 - 1. Central Leader for Single Trunk Trees: Trees shall have a single, relatively straight central leader and tapered trunk, free of co dominant stems and vigorous, upright branches that compete with the central leader. Preferably, the central leader should not have been headed; however, in cases where the original leader has been removed, an upright branch at least $\frac{1}{2}$ the diameter of the original leader just below the pruning point shall be present.
 - 2. Potential Main Branches: Branches shall be evenly distributed radially around and appropriately spaced vertically along the trunk, forming a generally symmetrical crown typical for the species.
 - 3. Headed temporary branches should be distributed around and along the trunk as noted above and shall be no greater than $\frac{3}{8}$ " diameter, and no greater than $\frac{1}{2}$ diameter of the trunk at point of attachment.
- H. Tree Trunk
 - 1. Trunk diameter and taper shall be sufficient so that the tree will remain vertical without the support of a nursery stake.

2. Trunk shall be free of wounds (except properly-made pruning cuts), sunburned areas, conks (fungal fruiting-bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers and/or lesions.
3. Tree trunk diameter at 6" above the soil surface shall be within the diameter range shown for each container size below, except where shown otherwise:

Container	Trunk Diameter in inches	Soil level from Container Top
5 gallon	0.5" to 0.75"	1.25 to 2"
15 gallon	0.75" to 1.0"	1.75 to 2.75"
4. Tree trunks shall be undamaged and uncut with all old abrasions and cuts completely callused over. Do not prune plants prior to delivery.

I. Tree Roots

1. Trunk root collar (root crown) and large roots shall be free of circling and/or kinked roots. Contractor may be required to remove soil near the root collar in order to verify that circling and/or kinked roots are not present.
2. The tree shall be well rooted in the container. When the trunk is lifted the trunk and root system shall move as one and the rootball shall remain intact.
3. The top-most roots or root collar shall be within 1" above or below the soil surface. The soil level in the container shall be within the limits shown in above table.
4. The rootball periphery shall be free of large circling and bottom-matted roots.
5. On grafted or budded trees, there shall be no suckers from the root stock.

J. Shrubs

1. Each shrub must stand upright without support.
2. All container shrubs shall be free of girdling roots, defined as those roots greater than 1/8" diameter circling the periphery of the rootball. The top of the rootball shall be free of "Knees" (roots) protruding above the soil, and the bottom shall be free of matted roots.

2.2 SPECIAL HYDROSEED MIXES FOR EROSION CONTROL (Non-irrigated unless noted otherwise)

- A. Seed: Incorporate the following seed uniformly in hydromulch with tackifier at the specified rates per acre. Provide seed of the latest crop, labeled in accordance with the California Food Agricultural Code with the following ingredients per acre:

1. Hydroseed Mix:
 - 65% Zorro Fescue (*Festuca megalura*)
 - 30% Hykon Clover / Rose Clover (*Trifolium hirtum*)
 - 5% Wildflower Mix
 - California Poppy (*Eschscholzia californica*)
 - Lupine (*Lupinus succulentus*)
 - Tidy Tips (*Layia platyglossa*)
 - Seed Rate: 60 lbs/acre
 - Wood Fiber: As specified below, minimum 1,800 lbs/acre
 - Fertilizer (16-20-0): 450 lbs/acre
 - Stabilizer: As provided with Hydroseed Mulch with Tackifier specified below, minimum 80 lbs/acre

As available from Pacific Coast Seed, Livermore, CA (925) 373-4417; Delta Growers Seed, Stockton, CA (209) 931-0684 and others.

- B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer's instructions.
- C. Seed Certification: All seed shall be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. In addition, the container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. Prior to seeding at the request of the owner, the contractor shall provide a letter of certification, original Association of Official Seed Analysts (AOSA) seed test results, and calculations of PLS content.
- D. Seed Inoculation: All legume seed shall be pellet-inoculated and provided in Bulletin AXT-280 of the University of California Cooperative Extension, "Pellet Inoculation of Legume Seed." Inoculant sources shall be species specific and shall be applied at a rate of 2 pounds of inoculant per one hundred pounds of seed.
- E. Fiber Mulch with Tackifier: "Conwed Fibers Hydro Blanket" at the rate of 4000lbs. per acre] "Conwed Fibers Flex Terra" at the rate of 4000 lbs. per acre, Buffalo Grove, IL, (800) 366-1180; EcoFiber; or equal fibrous, wood cellulose with tackifier containing no growth or germination inhibiting factors and manufactured in such a manner that after addition and agitation in slurry tanks with fertilizer, seed, water and other approved additives, the fibers in the material become uniformly suspended to form a homogeneous slurry; and that when hydraulically sprayed on the ground, the material forms a blotter-like ground cover impregnated uniformly with seed; and which, after application, allows the absorption of moisture and rainfall to percolate to the underlying soil. The fibrous mulch in its air-dry state shall contain not more than 15% by weight of water. The fiber shall have a temporary green dye and shall be accompanied by a certificate of compliance stating that the fiber conforms to these specifications.
- F. The Tackifier/Stabilizer: Shall be an organic substance supplied in powder form and shall be psilium-based and packed in clearly marked bags stating the contents of each package. The California Department of Food and Agriculture shall certify the material as an Auxiliary Soil Chemical.
- G. Hydroseed Fertilizer: Hydroseed fertilizer to be used in the slurry shall be commercial fertilizers conforming to the requirements of the California Food and Agricultural Code; uniform in composition, with a guaranteed chemical analysis of 16% Nitrogen, 20% Phosphoric Acid, and 0% Potash (16-20-0) plus Sulfur (approximately 15%).

2.3 FERTILIZERS

- A. Commercial fertilizer, pelleted or granular form, conform to the requirements of Chapter 7, Article 2, of the Agricultural Code of the State of California for fertilizing materials as follows:
 - 1. Type A:
6% Nitrogen, 20% Phosphorus Acid and 20% Potash, (6-20-20).
 - 2. Type B:
21 gram planting tablets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash

(20-10-5) available from Agriform or 10gm BestPacks packets 20% Nitrogen, 10% Phosphoric Acid and 5% Potash (20-10-5) available from Best Fertilizer Co.

3. Type C:
Complete fertilizer 21% Nitrogen, 7% Phosphoric Acid and 14% Potash (21-7-14).
4. If commercial fertilizer having this analysis is not obtainable, other similar commercial fertilizer may be used providing it meets the approval of the Owner's Representative.

B. Maintenance Fertilizer: Type C

C. IRON SULFATE: Agricultural dry form

2.4 ORGANIC AMENDMENT: For use with imported planting soils (on-grade)

A. Ground Redwood or Ground Fir Bark with the following properties:

<u>Percent Passing</u>	<u>Sieve Designation</u>	
100	9.51 mm	3/8"
50-60	6.35 mm	1/4"
20-40	4.76 mm	No. 4
0-20	2.38 mm	No. 8 8 mesh

Redwood Sawdust

Dry bulk density, lbs. per cu. yd., 260-280
Nitrogen stabilized - dry weight basis, min. 0.4%
Salinity (ECe): 4.0 maximum
Organic Content: 90% minimum
Reaction (pH): 4.0 minimum

Ground Fir and/or Pine Bark

Dry bulk density, lbs. per cu. yd., Min. 350
Nitrogen stabilized - dry weight basis, min. 0.5%
Salinity (ECe): 4.0 maximum
Organic Content: 90% minimum
Reaction (pH): 4.0 minimum

- B. Submittal: Submit sample along with analytical data from an approved laboratory for degree of compliance to the Owner's Representative within two weeks after award of Contract.

2.5 GROUND NITROLIZED FIR BARK ORGANIC AMENDMENT: For use with Raised Contained Planter Backfill Mix:

A. Ground Nitrolized Fir Bark with the following properties:

<u>Percent Passing</u>	<u>Sieve Designation</u>	
100	9.51 mm	3/8"
95-100	6.35 mm	1/4"
80-100	4.76 mm	No. 4
75-100	2.38 mm	No. 8 8 mesh

20-70
0-40

1.00 mm
500 micron

No. 18 16 mesh
No. 35 32 mesh

- a. Ground Fir
- b. Dry bulk density, lbs. per cu. yd., Min. 350
- c. Nitrogen stabilized - dry weight basis, min. 0.5%
- d. Salinity (ECe): 4.0 maximum
- e. Organic Content: 90% minimum
- f. Reaction (pH): 4.0 minimum

- B. Organic Amendment Submittal: Submit sample of Ground Nitrolized Fir bark Organic Amendment along with analytical data from an approved laboratory for degree of compliance.

2.6 MULCH

- A. Organic Mulch:
- 1. Walk-On Bark; Coarsely shredded White Fir, bark.
 - 2. Redwood Bark; Single grind (Coarse) Coast Redwood Bark (Gorilla Hair) – For steep slopes.
- B. Submittal: Submit samples of organic and rock mulches to the Owner's Representative for approval within two weeks of award of Contract. Resubmit until acceptable to Owner, at no extra cost.

2.7 TREE SUPPORT POLES (ON-GRADE PLANTING): Peeled lodge pole pine logs, clean, smooth, new, and sized as follows:

- A. Two-inch (2") diameter by eight feet (8') long for trees less than 8' high and 1" caliper.
- B. Three-inch (3") diameter by eight to ten feet (8' - 10') long for trees greater than 8' high and 1-1/2" and larger caliper.

2.8 TREE TIES

- A. Rubber strap, 24-inch minimum length without sharp edges adjacent to trunk, V.I.T. cinch-tie, Dublin, CA, (818)882-9530, or approved equal.

2.9 EXISTING PLANTING SOIL (TOPSOIL):

- A. Existing Planting Soil (TOPSOIL) is defined as on-site surface soil. Satisfactory planting soil shall be free of subsoil, clay, lumps, stones, and other objects over 4" in diameter, and without weeds, roots, and other objectionable material.
- B. Strip planting soil to whatever depths encountered, a maximum of 12 inches in a manner to prevent intermingling with the underlying subsoil or other objectionable

material. Topsoil stripping is limited to area outside "Drip Line" of existing trees to remain and areas indicated on drawings and as approved by the Owner's Representative.

- C. Remove heavy growths of grass from areas before stripping.
- D. Stockpile topsoil in storage piles in areas shown, or where designated by Owner. Do not mix topsoil with subsurface soils. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust.
- E. If herbicide contamination is suspected then a radish/ryegrass growth trial must be performed. Consult with Owner's Representative prior to decision to test or not.

2.10 IMPORTED PLANTING SOIL (TOPSOIL):

- A. Imported Planting Soil for general use in augmenting existing Site Planting Soil shall be fertile, friable, natural, productive soil containing a normal amount of humus, and shall be capable of sustaining healthy plant life. Imported planting soil shall be screened and shall be free of subsoil, heavy or stiff clay, rocks, gravel, brush, roots, weeds, noxious seeds, sticks, trash, and other deleterious substances. Soil shall not be infested with nematodes or with other noxious animal life or toxic substances. Soil shall be obtained from well-drained, arable land, and shall be of an even texture. Soil shall not be taken from areas on which are growing any noxious weeds such as Morning Glory, Sorrel, or Bermuda Grass.
- B. Imported Planting Soil shall have a pH value of between 6.0 and 7.5, a boron concentration of the saturation extract of less than 1 ppm, salinity of the saturation extract at 25 degrees C. of less than 4.0 millimoles, and a sodium absorption rate (SAR) of less than 8.
- C. The silt and clay content of Imported Planting Soil shall not exceed that of the existing soil it is to be placed over. Except where otherwise required, it shall be a "Sandy Loam" as classified in accordance with USDA Standards with a combined total of between 25% to 40% Clay and Silt.
- D. Submittal: submit for approval a 1-quart sample of proposed import soil, together with a standard soil analysis report by an accredited soils analyst showing chemical analysis stating source, fertility, agricultural suitability and particle size distribution of the soil. Deliver the sample to the Owner's Representative minimum two weeks before starting the contemplated hauling of the soil.
- E. Submittal: Also, provide Existing Site Soil sample analysis report for comparison with the Imported Planting Soil report.
- F. Following approval of the sample, provide a one-half cubic yard sample, which shall be stored at the site of work for comparison with subsequent loads of soil. The comparison sample shall be protected by a cover until the furnishing of all soil has been completed and accepted. Should the soil submittal lack certain requirements which can be added to the soil, the Owner's Representative will consider a request by the Contractor to amend the soil as recommended by the Soils Analyst at the Contractor's expense.

2.11 FILTER FABRIC

- A. Polyester or polypropylene non-woven filter fabric with uniform fiber distribution by "Terra Bond" #1115, "Mirafi, Inc." #140N, or approved equal.

2.12 PERMEABLE BACKFILL (FILTER ROCK)

- A. Permeable backfill used in subsurface drain installations to be Class 2 permeable material in conformance with Section 68 "Subsurface Drains" of the Standard Specifications; gradation to 3/4" maximum size without fines. Submit Sample for approval.

2.13 EROSION CONTROL NETTING

- A. New, with a uniform, open plain-weave, flame-retardant mesh. The mesh shall be natural brown-tan and made from unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one-half its normal diameter. Furnish jute mesh in rolled strips to meet the following requirements:
 - 1. Width: 48 inches, with a tolerance of one-inch wider or narrower.
 - 2. Not less than 78 warp ends per width.
 - 3. Not less than 41 weft ends per yard.
 - 4. Weight shall average 1.22 pounds per linear yard, with a tolerance of 5 percent heavier or lighter.

PART 3 - EXECUTION

3.1 FINE GRADING AND SOIL PREPARATION

- A. General
 - 1. Soil in all planting areas shall be moist, but not so moist that it sticks to a hand shovel, and loose and friable to a minimum depth of 12 inches with a relative maximum compaction of 85%. Rip and scarify and dry any areas that do not meet this requirement.
- B. Before proceeding with the work: Carefully inspect all areas and verify all dimensions and quantities. Immediately inform the Owner's Representative of any discrepancy between the drawings and specifications and actual conditions and secure approval to proceed.

3.2 Lime Treated Soil Removal

- A. All Lime treated soils shall be removed full depth of treated soil from planting areas where it occurs and replaced with approved planting soil as accepted by Owner's Representative.

- B. As-Built Drawing Requirement: Contractor shall field measure and record all lime treated areas on As Built Drawings showing both depth and extent of areas treated to aid in subsequent removal of material in planting areas.
- C. Following removal of lime treated material, scarify subgrade to a minimum depth of 6 inches and test for drainage.
- D. Test subgrade in all planting areas for drainage by flooding with minimum 4 inch depth of water puddle and verify complete absorption of standing water within two hours. If standing water is still present after two hours, provide perforated pipe and drain rock "French Drain" system in bottom of non-draining planters and connect to storm drainage system, as accepted by Owner's Representative prior to backfilling with approved planting soil.

3.3 PLANTING SOIL PLACEMENT

- A. All planting areas soil shall be loose and friable prior to planting. Planting operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped until conditions are satisfactory.
- B. Thoroughly wet down the planting areas to settle the soil and confirm irrigation coverage and operation. Allow soil to dry so as to be workable as described herein.
- C. Finish Grade: Hold finish grade and/or mulch surface in planting areas 1/2-inch below adjacent pavement surfaces, tops of curbs, manholes, etc. The subgrade of the mulch in mulched planting areas shall be a minus 2 inches.

3.4 EROSION CONTROL NETTING

- A. Verify finished grades and provide Jute Mesh with single grind Redwood bark mulch over the mesh on all slopes 3:1 and steeper as accepted by the Owner's Representative. Install jute mesh loosely up and down the slope in accordance with manufacturer's specifications and as follows. Fit the soil surface contour and hold in place with 12-inch long, 11-gauge (minimum) steel wire staples driven vertically into the soil at 18- to 24-inch spacing. Jute mesh strips shall overlap along all edges at least 6 inches. Ends of side strips shall be buried into the soil at least 6 inches. Drive staples along edges to securely anchor mesh to ground.

3.5 TREE AND SHRUB PLANTING

- A. Mark tree and shrub locations on site using stakes, gypsum or similar approved means and secure location approval by the Owner's Representative before plant holes are dug. Review location of plants in relationship to irrigation heads and adjust location(s) that interfere with the function of the heads as accepted by the Owner's Representative prior to planting.
- B. Test drainage of plant pits by filling with water (minimum 6"). The retention of water in planting beds and plant pits for more than two (2) hours shall be brought to the attention of the Owner's Representative.

- C. Excavate tree, shrub and vine pits as follows:
- | | | |
|---------------------------------|--------------|--------------|
| 1. <u>Excavation for</u> | <u>Width</u> | <u>Depth</u> |
| Boxed Trees | Box + 24" | depth of Box |
| Canned Trees (15 gc) | Can + 18" | depth of Can |
| Canned Shrubs/Vines (1 or 5 gc) | Can + 12" | depth of Can |
- D. Backfill plant holes with mix as specified, free from rocks, clods or lumpy material.
- E. Carefully remove and set plants without damaging the rootball. Superficially cut edge roots vertically on three sides. Remove bottom of plant boxes before planting. Remove sides of boxes after positioning the plant and partially backfilling.
- F. Set plants in backfill with top of the rootball 2 inches above finished grade. Backfill remainder of hole and soak thoroughly by jetting with a hose and pipe section. Water backfill until saturated the full depth of the hole.
- G. Build 6" high watering basin berms around trees and shrubs to drain through rootball. Basins are not required around trees in turf areas.
- H. Stake and/or guy trees as detailed and noted herein. Drive stake(s) until solid (at least 12" beyond bottom of rootball) and remove excess stake protruding above top tree tie to prevent rubbing against branches. Avoid driving stakes through rootball. If subgrade does not accept stakes to a stable degree, delete stakes and guy the trees as specified herein and as detailed. Locate tree ties to avoid contact with tree branches. Locate top tie at tree flex point.
- I. Remove any soil from top of plant rootballs and secure Owner's Representative's approval of rootball height prior to mulching.
- J. After approval of rootball height, install mulch as required below.

3.6 MULCH

- A. Except where rock mulch is required, mulch all tree and shrub areas with organic mulch to a 3-inch depth., Hold bark mulch away from base (trunk) of plant 4" or as directed by the Owner's Representative.

3.7 WATERING

- A. Water all trees, shrubs and ground cover immediately after planting. Apply water to all plants in sufficient amounts as conditions require to maintain the plants in a healthy vigorous growing condition until completion of the Contract. Do supplemental hand watering of plants as required to maintain optimum moisture in the root zones.

3.8 PRE-MAINTENANCE PERIOD REVIEW AND APPROVAL OF PLANTING

- A. Maintain plants from time of delivery to site until final acceptance of landscape installation.

- B. Receive approval of the installed planting prior to commencement of planting establishment maintenance period. Notify the Owner's Representative a minimum of seven (7) days prior to requested review. Before the review, complete the following:
 - 1. Complete all construction work.
 - 2. Present all planted areas neat and clean with all weeds removed and all plants installed and appearing healthy.
 - 3. Plumb all tree stakes.
 - 4. No partial approvals will be given.

3.9 PLANTING ESTABLISHMENT MAINTENANCE

- A. General Requirements:
 - 1. Maintenance Period: The planting establishment maintenance period required shall be 90 calendar days after all planting is complete, and installation approved. The maintenance period may be suspended at any time upon written notice to the Contractor that the landscaping is not being acceptably maintained, and the day count suspended until the landscape is brought up to acceptable standards as determined by the Owner's Representative.
 - 2. Planting establishment maintenance immediately follows, coincides with, and is continuous with the planting operations, and after all planting is complete and accepted; or longer where necessary to establish acceptable stands of thriving plants.
 - 3. Keep the site clear of debris resulting from landscape work and maintenance operations.
 - 4. Check irrigation system at each watering; adjust coverage and clean and repair non-functioning heads immediately. Adjust timing of system to prevent runoff and flooding.
 - 5. Maintain adequate moisture depth in soil to ensure vigorous growth, without overwatering. Check rootball of shrubs independent of surrounding soils and hand water as required.
 - 6. Keep Contract areas free from weeds by cultivating, hoeing or hand pulling.
- B. Plant Protection and Replacement
 - 1. Protect all areas against damage, including erosion, trespass, insects, rodents, deer, disease, etc. and provide proper safeguards, including trapping of rodent and applying protective sprays and fencing to discourage deer browsing. Maintain and keep all temporary barriers erected to prevent trespass.
 - 2. Repair all damaged planted areas. Replace plants immediately upon discovery of damage or loss, including damage from Deer and Rodents.
- C. Tree, Shrub and Ground Cover Maintenance:
 - 1. Maintain during the entire establishment period by regular watering, cultivating, weeding, repair of stakes and ties, and spraying for insect pests. Prune when requested by the Owner's Representative.
 - 2. Keep watering basins in good condition and weed-free at all times.
 - 3. Replace all damaged, unhealthy or dead trees, shrubs, vines and ground covers with new stock immediately; size as indicated on the drawings.
- D. Non-irrigated Hydroseeded Erosion Control Areas: To be watered by winter rains unless noted otherwise.

- E. Fertilizing:
 - 1. Upon approval and after submitting fertilizer delivery tags, maintenance fertilization shall begin 30 days after planting is complete. Fertilize ground cover areas by broad-casting Type C (21-7-14) fertilizer at the rate of 5 lbs. per 1,000 square feet evenly throughout. Reapply every forty-five (45) days until acceptable.
 - 2. Observe plant's color, and if a soil pH imbalance is suspected, take soil samples and obtain laboratory analysis for confirmation. Take necessary action recommended in laboratory analysis such as top dressing with soil sulfur, leaching soil, etc.

3.10 FINAL PLANTING REVIEW AND ACCEPTANCE

- A. At the conclusion of the Maintenance Period, schedule a final review with the Owner, the Owner's maintenance person, and the Owner's Representative. On such date, all project improvements and all corrective work shall have been completed. If all project improvements and corrective work are not completed, continue the planting establishment, at no additional cost to the Owner, until all work has been completed. This condition will be waived by the Owner under such circumstances wherein the Owner has granted an extension of time to permit the completion of a particular portion of the work beyond the time of completion set forth in the Agreement.
- B. Submit written notice requesting review at least 10 days before the anticipated review.
- C. Prior to review, weed and rake all planted areas, repair plant basins, mow and edge turf, plumb tree stakes, clear the site of all debris and present in a neat, orderly manner.

END OF SECTION

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SECTION 03100– CONCRETE FORMWORK

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and design, install and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.
- B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete.
- C. Forms for architectural concrete.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03200, Concrete Reinforcement
 - 2. Section 03150, Concrete Joints and Joint Accessories
 - 3. Section 03300, Cast-in-Place Concrete
 - 4. Section 03600, Grout
 - 5. Section 03740, Modifications and Repair to Concrete

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials
 - 2. ACI 301 - Specifications for Structural Concrete
 - 3. ACI 318 - Building Code Requirements for Structural Concrete
 - 4. ACI 347 – Guide to Formwork for Concrete
- B. American Plywood Association (APA)
 - 1. APA - Material Grades and Designations as Specified
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Form release agent
 - 2. Form ties
 - 3. Form liners
 - 4. Bond breakers
 - 5. Void Forms
 - 6. Architectural concrete forming system
- B. Falsework and Drawings: The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16-feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a Professional Civil Engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.
- C. The CONTRACTOR shall, in accordance with the requirements in Division 1, submit detailed plans of falsework proposed to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.
- D. Location and sequence of the concrete placement. Indicate locations of form joints, form-tie layout, panel sizes and patterns.
- E. Review of pour sequence, form system and panel layout shall be for appearance and conformance to design concept only. ENGINEER's review of the forming plans or procedures shall not relieve the CONTRACTOR of responsibility for the strength, safety or correctness of methods used, the adequacy of equipment, or from carrying out the work in full compliance with the requirements of the Drawings and as specified herein.
- F. Samples
 - 1. The CONTRACTOR shall construct one sample concrete wall 6 feet high by 6 feet long with the architectural forms and the form liner, complete with the form tie pattern and finish as specified. The wall will be viewed by the ENGINEER in the presence of the CONTRACTOR noting specific defects and establishing the quality of the finished architectural concrete for the project. The wall as modified by the ENGINEER'S comments shall serve as the standard against which the acceptability of the actual architectural concrete will be judged. The wall shall remain until all architectural concrete has been placed, finished, and accepted at

which time the CONTRACTOR shall demolish the wall and remove the debris from the site.

1.5 QUALITY ASSURANCE

- A. The form liner manufacturer's representative shall be on-site during initial installation of the form liner to instruct the CONTRACTOR on the proper methods of application and use of the liner. S/He shall be available to answer any questions on the liner that the ENGINEER may have.

1.6 SYSTEM DESCRIPTION

- A. General: Architectural Concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of the walls to 2-ft below the normal water surface in open tanks and basins.
- B. Structural Design Responsibility – All forms and shoring shall be designed at the CONTRACTOR's expense by a Professional Civil Engineer, registered in the State of California. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

- A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for the project shall be new and unused. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the ENGINEER and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.
- B. Wall Forms:
 - 1. Forms for all exposed exterior and interior concrete walls shall be new and unused "Plyform" exterior grade plywood panels manufactured in compliance with APA and bearing the trademark of that group, or equal acceptable to the ENGINEER. Provide B grade or better veneer [with High Density Overlay (HDO)] on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.

2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.
 3. Forms for circular structures shall conform to the circular shape of the structure. Straight panels may be substituted for circular panels if the straight panels do not exceed 2-ft in width nor deflect more than 3-1/2 degrees per joint, nor conflict with specific notes on the Drawings.
- C. Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.
- D. Form Release Agent – Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water-based, bond-breaking form coating, unless otherwise noted.
- E. Forms for Architectural Concrete or Concrete Receiving Architectural Finish.
1. Forms for architectural concrete shall be constructed of materials and in a manner that will result in rigid forms with sufficient strength to withstand, without noticeable deflection, movement, or leakage, the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Deflection in formwork shall be limited to 1/360 of each component span. Form joints shall be laid out in a uniform pattern or as indicated on the Drawings.
 2. Form material for producing architectural finishes shall be constructed of either steel fiberglass reinforced plastic or high density overlay plywood.
- F. Form Liners:
1. Architectural Formliners: Plastic Formliner, fluted Rib Pattern, 1 1/2" deep, 6" on center, 2 1/2" peak and valley. Dayton Superior 1 1/2" Deep Rib Pattern F940012; Fitzgerald Formliners VinylLok Fluted Rib Pattern 14314, or equivalent.
- G. Form Ties:
1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1 1/2-inches of the face of the concrete. The part of the tie to be removed shall be at least 1/2-inch diameter or be provided with a wood or metal cone at least 1/2-inch diameter and 1 1/2-inches long. Form ties in concrete exposed to view shall be the cone-washer type.
 2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be approved wood or plastic.

3. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1½-inches and sufficient dimensions to permit proper patching of the tie-hole.
4. Ties for liquid containment structures shall have a neoprene washer at the center of the tie. Snap-Ties shall be Meadow Burke, Tampa, FL , Gates & Sons, Inc., Denver, CO, or approved equal.
5. Common wire shall not be used for form ties.
6. Alternate form ties consisting of tapered through-bolts at least 1-inch in diameter at the smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the CONTRACTOR's option. Obtain ENGINEER's acceptance of system and spacing of ties prior to ordering or purchasing of forming. Clean, fill and seal form tie hole with non-shrink cement grout. The CONTRACTOR shall be responsible for water-tightness of the form ties and any repairs needed.

H. Void Forms.

1. Void forms used directly below structural slabs shall be 8-in deep preformed cardboard having sufficient strength to support the weight of the reinforcement and the wet concrete placed directly above or adjacent to it without deflecting the void form more than ½-in. Manufacturers include Vertical Chicago Inc., Melrose Park, IL – Vertical Core Material ½-in 50-50-0; Falcon Manufacturing Co., Denver, CO – Sure Void Under Slab Void, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

- A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings.
- B. Forms for walls shall have removable panels at the bottom for cleaning, inspection and joint surface preparation. Forms for wall heights in excess of 16 feet shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, prevent segregation, and prevent the accumulation of hardened concrete on the forms above the fresh concrete.
- C. Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a ¾-inch chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the drawings. Size of moldings shall conform to the sealant manufacturer's recommendations.
- D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms such that the concrete and/or exposed rebar (dowels) will not be damaged by their removal. The CONTRACTOR shall be entirely responsible for the adequacy of the forming system.

- E. Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like-new" condition of the form is maintained.
- F. Metal items, such as rebar, wire, or plates used to support pipe penetrations and pipe embedment shall have a minimum clearance of 2-inches from reinforcing bars.
- G. Tolerances in concrete construction shall be in accordance with ACI 117, unless otherwise noted.

3.2 FORM TOLERANCE

- A. Forms shall be surfaced, designed, and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for specified finishes.
- B. Formed Surfaces Exposed to View – Edges of all form panels in contact with concrete shall be flush within 1/32-inch and forms for plane surfaces shall be such that the concrete will be plane within 1/16-inch in 4-feet. Forms shall be tight to prevent the passage of mortar, water, and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-inch from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.
- C. Formed surfaces not exposed to view or buried shall meet the requirements of Class "C" Surface in ACI 347.
- D. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1-inch.
- E. Architectural Concrete: All smooth faces to be exposed to view shall have surface deflections limited to 1/32-in at any point and the variation in wall deflection shall not exceed 1/16-in per 4-ft. The maximum deviation of the finished wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings. All textured faces, form lines, or rustications to be exposed to view shall be straight, plumb and true with a variation of no more than 1/4-in in 10-ft measured in any direction.

3.3 FORM PREPARATION

- A. Wood forms in contact with concrete shall be coated with an effective release agent prior to form installation.
- B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.
- C. Form liners to be installed for architectural concrete finish shall be in accordance with the manufacturer's recommendations.

3.4 REMOVAL OF FORMS

- A. The CONTRACTOR shall be responsible for all damage resulting from removal of forms. Form removal shall conform to the requirements specified in Section 03300.
- B. Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with the requirements of this Section, shall be grounds for rejection of that portion of the form/concrete work. Rejected work shall be repaired or replaced as directed by the ENGINEER at no additional cost to the OWNER. Such repair or replacement shall be subject to the requirements of this Section and approval of the ENGINEER.

3.5 FALSEWORK

- A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements specified herein.
- B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.
- C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20-tons. When falsework is supported on any portion of the structure, which is already constructed, the loading imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

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SECTION 03150 – CONCRETE JOINTS AND JOINT ACCESSORIES

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork
 - 2. Section 03200, Concrete Reinforcement
 - 3. Section 03300, Cast-in-Place Concrete
 - 4. Section 03366, Tooled Concrete Finishes.
 - 5. Section 03600, Grout
 - 6. Section 03740, Modifications and Repair to Concrete.
 - 7. Section 05500, Miscellaneous Metals

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Federal Specifications
 - 1. SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.
- B. ASTM International (ASTM)
 - 1. ASTM A675 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
 - 2. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 3. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 - 4. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).
 - 5. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

C. US Army Corps of Engineers (CRD)

1. CRD-C 572 - Specification for Polyvinylchloride Waterstops.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:

1. Waterstops - product data including catalogue cut, technical data, storage requirements, splicing methods and conformity to ASTM standards.

2. Premolded Joint Fillers - product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

3. Bond Breaker - product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

4. Compressible Joint Filler - product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

5. Bonding Agents - product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.

6. Samples - two samples of each type of waterstop fitting(s).

B. Certifications:

1. Certification that all materials used within the joint system are compatible with each other.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than five years.

2.2 MATERIALS

- A. PVC Waterstops (Standard) – The PVC waterstops shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C 572.
1. Waterstops for expansion joints shall be 9-inches wide and be ribbed type with a center bulb. Expansion joint waterstops shall be style 696 by Greenstreak Corporation, St. Louis, MO; style RB9-38H by Vinylex Corporation, Knoxville, TN; or equal.
 2. Waterstops for non-expansion joints shall be 6-in wide and be the flat ribbed type. Non-expansion joint waterstops shall be style 679 by Greenstreak Incorporated, St. Louis, MO; style R6-38 by Vinylex Corp., Knoxville, TN, or equal. Equal waterstops may have an integral fastening system
- B. Premolded Joint Filler:
1. Premolded joint filler - Structures. Self-expanding cork, premolded joint filler shall conform to ASTM D1752, Type III. The thickness shall be 3/4-in unless shown otherwise on the Drawings.
 2. Premolded joint filler - sidewalk and roadway concrete pavements or where fiber joint filler is specifically noted on the Drawings. The joint filler shall be asphalt-impregnated fiberboard conforming to ASTM D1751. Thickness shall be 3/4-in unless otherwise shown on the Drawings.
- C. Bond Breaker:
1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape that will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.
 2. Except where tape is specifically called for on the Drawings, bond breaker for concrete shall be either bond breaker tape or a non-staining type bond prevention coating such as Silcoseal Select, by Nox-Crete, Omaha, Nebraska; or equal.
- D. Bonding Agent:
1. Epoxy bonding agent shall be two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation; Concreative Liquid LPL by BASF Building Systems; or equal.
 2. Latex bonding agent shall be non-reemulsifiable acrylic-polymer latex conforming to ASTM C1059, Type II.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Standard Waterstop:

1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. All fittings shall be factory made or shop welded in accordance with manufacturer's recommendations. Only straight butt splices shall be fabricated in the field.
2. PVC splices shall be made by welding in accordance with the manufacturer's recommendations, subject to acceptance of the ENGINEER. Only manufacturer's special approved tools shall be used for welding. The finished splices shall provide a cross-section that is dense and free of porosity.
3. To properly secure PVC waterstops in wall joints before concrete is placed, center the waterstop in the joint. Clamp both edges of the waterstop and fasten to reinforcing steel with black annealed steel tie wire as specified for tying reinforcing steel and secure in place so that the waterstop will be perpendicular to the joint and remain in the required position during concrete placement. The spacing of the waterstop ties shall match the spacing of the adjacent reinforcing, but need not be spaced closer than 12-in on center.
4. Horizontal PVC waterstops in slabs shall have the edge of the waterstop lifted while placing concrete below the waterstop. Then the waterstop shall be manually forced against and into the placed concrete and covered with fresh concrete, to ensure adequate encasement of the waterstop in concrete.
5. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of splices.
6. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete.
7. Waterstops shall be terminated 3-in below the exposed top of walls.

B. Construction Joints:

1. Make construction joints only at locations shown on the Drawings or as approved by the ENGINEER. Any additional or relocation of construction joints proposed by the CONTRACTOR, must be submitted to the ENGINEER for written approval.
2. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.
3. Provide sealant grooves for joint sealant where indicated on the Drawings.
4. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately ¼-inch to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water blasting or sandblasting and prepare for bonding. At least 2 hours before and again shortly before the new concrete is deposited, the joints and adjacent concrete surfaces to at least 12-inches past the joint shall be saturated with water.
5. In lieu of the above method for bonding plastic concrete to hardened concrete, the following optional method may be used. Concrete must be allowed to set a minimum

of 28 days. Use a latex-bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations.

6. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
7. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the ENGINEER.

C. Control Joints:

1. Provide sealant grooves, sealants and waterstops at control joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.
2. Control joints may be sawed if specifically approved by the ENGINEER. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.
3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface of the joint with a bond breaker prior to placing new concrete against the joint. Avoid coating reinforcement or waterstops with bond breaker at these locations.

END OF SECTION

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SECTION 03200– CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork.
 - 2. Section 03150, Concrete Joints and Joint Accessories.
 - 3. Section 03300, Cast-in-Place Concrete.
 - 4. Section 03600, Grout.
 - 5. Section 03740, Modifications and Repair to Concrete.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Federal Specifications.
 - 1. QQ-W-461H - Wire, Steel, and Carbon (round, bare and coated).
- B. American Concrete Institute (ACI)
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 3. ACI 318 - Building Code Requirements for Structural Concrete.
 - 4. ACI SP-66 - ACI Detailing Manual.
- C. ASTM International (ASTM)
 - 1. ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 3. ASTM A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.

4. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

D. American Welding Society (AWS)

1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

E. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI - Manual of Standard Practice.

- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Reinforcing Steel – Submit to the ENGINEER, in accordance with Division 1, placement drawings conforming to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included in a single placement drawing or cross-referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc.) shown on the standard details sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.

- B. Bar Bending Details – The bars shall be referenced to the same identification marks shown on the placement drawings. Bars to have special coatings and/or to be of special steel or special yield strength shall be clearly identified.

- C. Mechanical Connectors – Submit two samples of each type of mechanical reinforcing steel connectors.

- D. Test Reports – Submit test reports for each of the following items:

1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.
2. Certified copy of test reports for each foreign manufactured steel proposed for use in the fabrication of reinforcement. The tests shall be specifically made for this project at the expense of the CONTRACTOR by a domestic independent testing laboratory certified to perform the tests. The testing shall be for conformity to the applicable ASTM standard(s).
3. Certified copy of welding test reports for rebar cages fabricated using Schnell IDEA Machine.
4. Welder certification. The certification shall be in accordance with AWS D1.4 when welding of reinforcement is required.

1.5 QUALITY ASSURANCE

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement has

been observed by the ENGINEER and the ENGINEER's release to proceed with concreting has been obtained. The ENGINEER shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the ENGINEER has completed their observations of the reinforcing steel.

1.6 DELIVERY, HANDLING AND STORAGE

- A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.
- B. Reinforcing steel shall be shipped and stored with bars of the same size and shape, fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted Placement Drawings.
- C. Reinforcing steel shall be stored off the ground, protected from moisture and kept free from dirt, oil, or other injurious contaminants.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.2 MATERIALS

- A. Materials shall be new and shall comply with the following material specifications:
- B. Deformed Concrete Reinforcing Bars – ASTM A615, Grade 60 deformed bars.
- C. Concrete Reinforcing Bars required on the Drawings to be Field Bent or Welded – ASTM A706, Grade 60 deformed bars.
- D. The following alternative materials are allowed:
 - 1. ASTM A615, Grade 60 may be used for ASTM A706 provided the following requirements are satisfied:
 - a. The actual yield strength of the reinforcing steel based on mill tests shall not exceed the specified yield strength by more than 18,000 psi. Retests shall not exceed this value by more than an additional 3,000 psi.
 - b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement shall not be less than 1.25.
 - c. The carbon equivalency (CE) of the bars shall be 0.55 or less.
- E. Reinforcing Steel Accessories:
 - 1. Plastic Protected Bar Supports – CRSI Bar Support Specifications, Class 1 – Maximum Protection.

2. Stainless Steel Protected Bar Supports – CRSI Bar Support Specifications, Class 2 – Moderate Protection.
3. Precast Concrete Block Bar Supports (Dobies): CRSI Bar Support Specifications, Precast Block. Block shall have equal or greater compressive strength than the surrounding concrete.

F. Tie Wire:

1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire, conforming to Federal Specification QQ-W-461H.

G. Mechanical reinforcing steel butt splices shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products, Inc., Solon, OH or equal. They shall meet all ACI 318 Building Code requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Bar couplers shall be torqued to manufacturer's recommended value.

1. Unless otherwise noted on the Drawings, mechanical tension splices shall be designed to produce splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the rebar.
2. Compression type mechanical splices shall provide concentric bearing from one bar to the other and shall be capable of developing the ultimate strength of the rebar in compression.

H. Fibrous Reinforcement – The fibers shall be 100 percent virgin homopolymer polypropylene fibrillated fibers, containing no reprocessed olefin materials, manufactured in accordance with applicable building codes and ASTM C116, Type II. Fibrous concrete reinforcement shall be Fibermesh 300, as manufactured by Propex Concrete Systems Corporation, Chattanooga, TN; or approved equal.

1. Acceptable polypropylene fibers shall possess the following characteristics:
 - a. Specific Gravity: 0.91
 - b. Tensile Strength: 80-100 ksi
 - c. Fiber Length: Grade per Manufacturer

2.3 FABRICATION

- A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice.
- B. Bars shall be cold bent. Bars shall not be straightened or re-bent.
- C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by ACI 318.

- D. Bar ends that are to be butt-spliced, placed through diameter holes in metal, or threaded, shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1½-degrees of a right angle to the axis of the bar.
- E. Schnell IDEA Machine- CONTRACTOR may fabricate rebar cage for beams using the Schnell IDEA Machine, with the following provisions:
 - 1. Fabrication of pre-assembled steel cages shall be in the shop of a fabricator licensed to use the Schnell IDEA Machine and with an in-house quality assurance program;
 - 2. Shipping of pre-assembled steel cages to the project site will include a copy of the rebar certificate from the mill and a copy of the welding test report from an approved third party test lab, engaged by and at the expense of the CONTRACTOR. The welding test is for the purpose of providing assurances that the rebar was not damaged during the welding operations; and
- F. Rebar to be welded shall comply with ASTM A706, Grade 60

PART 3 EXECUTION

3.1 INSTALLATION

- A. Surface condition, bending, spacing, and tolerances of placement of reinforcement shall comply with CRSI Manual of Standard Practice. The CONTRACTOR shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.
- B. Except as otherwise noted on the Drawings, the minimum concrete cover for reinforcement shall be as follows:
 - 1. Concrete cast against and permanently exposed to earth: 3-inches.
 - 2. Concrete exposed to soil, water, sewage, sludge and/or weather (including bottom cover of slabs over water or sewage): 2-inches.
 - 3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells and folded plate members – 1½-inch.
 - b. Beams: Primary reinforcement – 2-inch.
 - c. Ties, spirals and stirrups – 1-1/2-inch.
- C. Reinforcement, which will be exposed for a considerable length of time after being placed, shall be coated with a heavy coat of neat cement slurry.
- D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the ENGINEER. All bars that have been welded, including tack

welds, without such approval shall be immediately removed from the work. If welding of reinforcement is approved or specifically called for, it shall comply with AWS D1.4.

- E. Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items, may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacements of bars to avoid interference shall only be made with the approval of the ENGINEER. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the ENGINEER.
- F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the ENGINEER. If authorized, bars shall be cold-bent around a standard diameter spool as specified within CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld, or otherwise repair as directed by the ENGINEER. Do not bend reinforcement after it is embedded in concrete unless specifically permitted on the Drawings.

3.2 REINFORCEMENT AROUND OPENINGS

- A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one-half of the cross-sectional area of the reinforcing steel interrupted by the opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.3 SPLICING OF REINFORCEMENT

- A. Splices designated as compression splices on the Drawings shall be 30 bar diameters, but not less than 12-inches, unless otherwise noted.
- B. Tension lap splices shall be provided at all laps in compliance with ACI 318. The length of splices shall conform to the Contract Drawings. Splices in adjacent bars shall be staggered. Class A splices may be used when 50-percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.
- C. Except as otherwise indicated on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent bars shall not be spliced within the required lap length.
- D. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters, but not less than 24-inches. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the ENGINEER.

3.4 ACCESSORIES

- A. Determine, provide and install accessories such as chairs, chair-bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B. Use precast concrete blocks (dobies) where the reinforcing steel is to be supported over soil. In no case shall such supports be continuous.
- C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use of galvanized or plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fasteners to the bottom and top mats may be used if approved by the ENGINEER.

3.5 INSPECTION

- A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing, and position of the reinforcement has been observed by the ENGINEER and the ENGINEER's release to proceed with the concreting has been obtained. The ENGINEER shall be given a minimum of 24 hours prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the ENGINEER has completed their observations of the reinforcing steel.

END OF SECTION

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SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor and materials required and install all cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish all sampling and testing of products and materials by an independent testing laboratory acceptable to the ENGINEER but engaged by and at the expense of the CONTRACTOR.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork.
 - 2. Section 03150, Concrete Joints and Joint Accessories.
 - 3. Section 03200, Concrete Reinforcement.
 - 4. Section 03366, Tooled Concrete Finishes.
 - 5. Section 03600, Grout.
 - 6. Section 03740, Modifications and Repair to Concrete.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - 2. ACI 305R – Guide to Hot Weather Concreting.
 - 3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 5. ACI 318 - Building Code Requirements for Structural Concrete.
- B. ASTM International (ASTM)
 - 1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
9. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
14. ASTM C311 - Standard Test Methods for Sampling and Testing Fly-Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
15. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
17. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete.
18. ASTM C1017 - Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.

- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:
1. Sources of cement, pozzolan, and aggregates.
 2. Safety Data Sheets (SDS) for all concrete components and admixtures.
 3. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.

4. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, and conformity to ASTM standards.
5. High range water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations for use.
6. Concrete mix design for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, type and manufacturer of cement, compressive strength, concrete slump, shrinkage, and air content. Provide with (a) or (b) below for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records, OR,
 - b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28-day cylinder strength test results for each mix. Provide results of 7 and 14 day tests if available.
7. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standards.
8. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.
9. Samples – Fine and coarse aggregates if requested by the ENGINEER.
10. Test Reports – Submit test reports for each of the following items.
 - a. Fine aggregates – sieve analysis, physical properties, and deleterious substance.
 - b. Coarse aggregates – sieve analysis, physical properties, and deleterious substance.
 - c. Cements – chemical analysis and physical properties for each type.
 - d. Pozzolans – chemical analysis and physical properties.
11. Certifications:
 - a. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
 - b. Certify the Contractor is not associated with the independent testing laboratory nor does the Contractor or its officers have a beneficial interest in the laboratory.
12. Shrinkage test reports.
13. Work Plans:

- a. Hot weather concreting.
- b. Cold weather concreting.

1.5 QUALITY ASSURANCE

- A. Reinforced concrete shall comply with ACI 318, and other stated requirements, codes and standards. The most stringent requirement of the codes, standards and this Section shall apply when conflicts arise.
- B. Only one source of cement and aggregate shall be used on any one structure. Concrete shall be uniform in color and appearance.
- C. Well in advance of placing concrete, discuss with the ENGINEER the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops, and curing. Propose methods of hot and cold weather concreting as required.
- D. A meeting shall be held prior to placement of plasticized concrete. The plasticizer (high range water reducer) manufacturer's representative and the Contractor shall be available to discuss the properties and techniques of batching and placing plasticized concrete.
- E. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the ENGINEER may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the CONTRACTOR's expense.
- F. If, during the progress of work, the materials from the sources originally accepted change in characteristics, the CONTRACTOR shall, at their expense, make new acceptance tests of aggregates and establish new design mixes.
- G. Testing of the following materials shall be furnished by the CONTRACTOR to verify conformity with this Specification Section and the stated ASTM Standard(s).
 - 1. Fine aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances.
 - 2. Coarse aggregates for conformity to ASTM C33 – sieve analysis, physical properties, and deleterious substances.
 - 3. Cements for conformity to ASTM C150 – chemical analysis and physical properties.
 - 4. Pozzolans for conformity to ASTM C618 – chemical analysis and physical properties.
 - 5. Proposed concrete mix design(s) – compressive strength, slump, shrinkage, and air content.
- H. The OWNER will provide field-testing and inspection services. The cost of such work, except as specifically stated otherwise, shall be paid by the OWNER. Testing of the following items shall be by the OWNER to verify conformity with this Specification Section.
 - 1. Concrete placement – compressive strength (cylinders), compressive strength (cores), slump, air content, and shrinkage.

2. Other materials or products that may come under question.
 - I. All materials incorporated in the work shall conform to accepted samples.
- 1.6 DELIVERY, HANDLING AND STORAGE
- A. Cement – Store in weather tight buildings, bins, or silos to provide protection from dampness and contamination and to minimize warehouse set.
 - B. Aggregate – Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Do not use frozen or partially frozen aggregate.
 - C. Sand – Arrange and use stockpiles to avoid contamination. Allow sand to drain to uniform moisture content before using. Do not use frozen or partially frozen sands.
 - D. Admixtures – Store in closed containers to avoid contamination, evaporation, or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions that tend to separate. Protect liquid admixtures from freezing and other temperature changes that could adversely affect their characteristics.
 - E. Pozzolan – Store in weather tight buildings, bins, or silos to provide protection from dampness and contamination.
 - F. Sheet Curing Materials – Store in weather tight buildings or off the ground and under cover.
 - G. Liquid curing compounds – Store in closed containers.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's services.

2.2 MATERIALS

- A. Materials shall comply with this Section and any applicable State or Local requirements.
- B. Cement – Domestic Portland cement complying with ASTM C150 Type I or II. Air entraining cement shall not be used. Cement brand shall be subject to approval by the ENGINEER and one brand shall be used throughout the Work.
- C. Fine Aggregates – Washed inert natural sand conforming to the requirements of ASTM C33.
- D. Coarse Aggregates – Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified coarse aggregate size number. Limits of Deleterious Substances and Physical Property Requirements shall be as listed in ASTM C33 Table 3 for severe

weathering regions. Size numbers for concrete mixes shall be as shown in Table 1 herein.

- E. Water – Potable water free from injurious amounts of oil, acids, alkalis, salts, organic matter, or other deleterious substances. Use of reclaimed or recycled process water is not permitted.
- F. Admixtures – Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures.
 - 1. Air Entraining Admixture – The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 2. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the ENGINEER. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
 - 3. Water-Reducing Admixture – The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - 4. High-Range Water Reducer (Plasticizer) – The admixture shall comply with ASTM C494, Type F and shall result in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
- G. Pozzolan (Fly Ash) – Pozzolan shall be Class F fly ash complying with ASTM C618, except the Loss On Ignition (LOI) shall be limited to 3 percent maximum. Use of Class C or Class N fly ash is not permitted.
- H. Sheet Curing Material – waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all which must comply with ASTM C171.
- I. Liquid Curing Compound – Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil.

2.3 CONCRETE MIXES

- A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the ENGINEER engaged by and at the expense of the CONTRACTOR.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture that will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

- C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the ENGINEER, engaged by and at the expense of the CONTRACTOR. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7 and 28 day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.
- D. Compression Tests – Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraph.
- E. Shrinkage Tests – Perform shrinkage tests for Class D concrete. The tests shall conform to ASTM C157 as modified by ASTM C596. Concrete and not mortar specimens shall be used.
1. The average shrinkage at 25 days of air storage shall not exceed 0.036 percent.
- F. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.
- G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10-in.
- H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

Table 1
Concrete Mix Requirements

<u>Class</u>	<u>Design Strength</u> <u>(1)</u>	<u>Cement</u> <u>(2)</u>	<u>Fine Aggregate</u> <u>(2)</u>	<u>Coarse Aggregate</u> <u>(3)</u>	<u>Cementitious Content</u> <u>Lbs. (min)</u> <u>(4)</u>
A	2500	C150 Type II	C33	57	440
B	3000	C150 Type II	C33	57	480
D	4500	C150 Type II	C33	57	560

<u>Class</u>	<u>W/C Ratio (Max.)</u> <u>(5)</u>	<u>Fly Ash</u> <u>(6)</u>	<u>AE Range</u> <u>(7)</u>	<u>WR</u> <u>(8)</u>	<u>HRWR</u> <u>(9)</u>	<u>Slump Range</u> <u>Inches</u>
A	0.62	--	3.5 to 5	Yes	No	1-4
B	0.54	--	3.5 to 5	Yes	No	1-3
D	0.44	15-25%	3.5 to 5	Yes	No	3-5

NOTES:

- (1) Minimum compressive strength in psi at 28 days
- (2) ASTM designation
- (3) Size Number in ASTM C33
- (4) Cementitious content in lbs/cu-yd
- (5) W/C is Water-Cementitious ratio by weight
- (6) Percent content of total Cementitious material
- (7) AE is percent air-entrainment
- (8) WR is water-reducer admixture
- (9) HRWR is high-range water-reducer admixture

PART 3 EXECUTION

3.1 MEASURING MATERIALS

- A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be produced by a plant acceptable to the ENGINEER. All constituents, including admixtures, shall be batched at the plant except a high-range water-reducer may be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.
- C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batching tickets.
- D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTATION

- A. Concrete shall be ready-mixed concrete. No hand mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the nameplate.
- C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be approved by the ENGINEER. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket.
- D. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.
- E. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal-lined non-aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar that has reached initial set will not be permitted.

- G. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting, or delays in placing successive layers of concrete in the forms.
- H. Furnish a delivery ticket for ready mixed concrete to the ENGINEER as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.

3.3 TEMPERATURE AND MIXING TIME CONTROL

- A. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees F.
- B. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
- C. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.
- D. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the values shown in Table 2.
- E. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

Table 2
Maximum Time to Discharge of Concrete

<u>Air or Concrete Temperature</u> <u>(Whichever is higher)</u>	<u>Maximum Time</u> <u>(Minutes)</u>
70 to 90 Degree F (21 to 32 Degree C)	60
40 to 69 Degree F (5 to 20 Degree C)	90

3.4 CONCRETE APPEARANCE

- A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:

1. The gradation of the aggregate.
 2. The proportion of fine and coarse aggregate.
 3. The percentage of entrained air, within the allowable limits.
- B. Concrete for the work shall provide a homogeneous structure which, when hardened, will have the required strength, durability and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10-ft away, shall be pleasing in appearance, and at 20-ft shall show no visible defects.

3.5 PLACING AND COMPACTING

A. Placing:

1. Placing of all concrete shall be in accordance with the recommendations contained in ACI 304R.
2. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, excess water, dirt and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent worker at the location of the placement that can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous sub grades or forms to eliminate suction of water from the mix. Seal extremely porous sub grades in an approved manner.
3. Deposit concrete as near to its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate that ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete that has partially hardened or has been contaminated by foreign materials or on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
4. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
5. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
6. Do not place concrete for supported elements until concrete previously placed in the supporting element (slabs and/or walls) has reached adequate strength.

B. Slabs:

1. After suitable bulkheads, screeds and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.

2. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.
3. "Jitterbugs" shall not be used on slab surfaces to aid in finishing.
4. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.

C. Formed Concrete:

1. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12 to 24-in lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 7-ft and the maximum free fall of concrete shall not exceed 15-ft.

D. Compacting:

1. Consolidate concrete by vibration, puddling, spading, rodding or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings and into corners of forms. Puddling, spading, etc, shall be continuously performed along with vibration of the placement to eliminate air or stone pockets that may cause honeycombing, pitting or planes of weakness.
2. All concrete shall be placed and compacted with mechanical vibrators. The number, type and size of the units shall be approved by the ENGINEER in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job site.
3. A minimum frequency of 7000 rpm is required for mechanical vibrators. Insert and withdraw vibrators vertically at points from 18 to 30-in apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over-vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.
4. Concrete Slabs – Concrete for slabs less than 8-in thick shall be consolidated with vibrating screeds; slabs 8 to 12-in thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
5. Walls – Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the ENGINEER. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.

6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until:
 - a. Frequency returns to normal.
 - b. Surface appears liquefied, flattened and glistening.
 - c. Trapped air ceases to rise.
 - d. Coarse aggregate has blended into surface, but has not disappeared.

3.6 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Curing Methods:
 1. Curing Methods for Concrete Surfaces – Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:
 - a. Water Curing – Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.
 - b. Sheet Material Curing – Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing – Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.
- C. Specified Applications of Curing Methods:
 1. Slabs for Water Containment Structures – Water curing only.
 2. Slabs on Grade and Footings (not used to contain water) – Water curing, sheet material curing, or liquid membrane curing.
 3. Structural Slabs (other than water containment) – Water curing or liquid membrane curing.
 4. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate – Water curing.

5. Formed Surfaces - None if nonabsorbent forms are left in place 7 days. Water cure if absorbent forms are used. Sheet cured or liquid membrane cured if forms are removed prior to 7 days. Exposed horizontal surfaces of formed walls shall be water cured for 7 days or until next placement of concrete is made.
 6. Concrete Joints – Water cured or sheet material cured.
- D. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.7 REMOVAL OF FORMS

- A. Except as otherwise specifically approved by the ENGINEER, forms shall not be removed before the concrete has attained a strength of at least 30 percent of its specified design strength, nor before reaching 100 Degree-Days of curing for walls and vertical surfaces, and 500 Degree-Days of curing for beams and slabs, (whichever is the longer). Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g.: 5 days at an average 70 degrees F = 350 degree-days).
- B. Shores shall not be removed until the concrete has attained at least 60 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.

3.8 INSPECTION AND FIELD TESTING

- A. The batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the ENGINEER at all times. The CONTRACTOR shall advise the ENGINEER of their readiness to proceed at least 24 hours prior to each concrete placement. The ENGINEER will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the ENGINEER.
- B. Sets of field control cylinder specimens will be taken by an independent entity paid for by the OWNER during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 150 cu-yds of concrete nor less than one set for each 3,000 sq ft of surface area for slabs or walls. If the total volume of concrete were such that the frequency of testing required for a given class of concrete would provide less than five strength tests, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are anticipated.
- C. A "set" of test cylinders consists of six cylinders: two to be tested at seven days and two to be tested and their strengths averaged at 28 days. The final two may be used for a special test at three days or to verify strength after 28 days if 28-day test results are low. CONTRACTOR shall provide a copy of all concrete test results to the OWNER for their review.
- D. When the average 28 day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum seven day strengths (where proper relation between seven and 28 day strengths have been established by tests),

proportions, water content, or temperature conditions shall be changed to achieve the required strengths.

- E. The CONTRACTOR shall cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations and furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the OWNER. Curing boxes shall be acceptable to the ENGINEER.

F. Concrete Slump:

1. Slump tests will be made in the field immediately prior to placing the concrete by an independent entity paid for by the OWNER. Such tests shall be made in accordance with ASTM C143. If the slump is greater than the specified range, the concrete shall be rejected.
2. At a minimum the first three trucks shall be tested to establish consistency. Additionally, testing will be performed with each strength test (cylinders) and each air-entrainment test.
3. The ENGINEER reserves the right to increase the frequency of testing when deemed necessary.

G. Air Content:

1. Test for air content (entrapped + entrained) shall be made on a fresh concrete sample by an independent entity paid for by the OWNER. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used. If air content is below the specified range air-entraining admixture may be added on-site to bring the concrete within specifications. If air content (entrapped + entrained) is above the specified range, the concrete shall be rejected.
2. At a minimum, the first three trucks shall be tested to establish consistency, then every third truck thereafter. Additionally, an air-entrainment test shall be performed with each strength test (cylinders). Concrete samples for the testing of air-entrainment shall be taken at the point of placement and not at the truck chute/hopper.
3. The ENGINEER reserves the right to increase the frequency of testing when deemed necessary.

H. Shrinkage:

1. Field shrinkage specimens shall be taken and tested by an independent entity paid for by the OWNER during the progress of the work.
2. Field test specimens of concrete for water containment structures, shall be taken with each strength test sampling (cylinders).

3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.
 4. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the OWNER, to achieve the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.
- I. The ENGINEER may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.
 - J. The CONTRACTOR shall cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes. The work of cutting and testing the cores will be at the expense of the OWNER.

3.9 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the ENGINEER shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the ENGINEER shall have the right to require additional curing on those portions of the structure represented by the test specimens that failed. The cost of such additional curing shall be at the CONTRACTOR's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the ENGINEER shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the CONTRACTOR. In such cases of failure to meet strength requirements, the CONTRACTOR and ENGINEER shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the CONTRACTOR in this Section.
- B. When the tests on field control specimens of concrete fall below the specified strength, the ENGINEER will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the ENGINEER, in addition to other recourses, may require, at the CONTRACTOR's expense, load tests on any one of the elements in which such concrete was used. Tests need not be made until concrete has aged 60 days.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.10 PATCHING AND REPAIRING

- A. It is the intent of this Section to require quality work including adequate forming, proper mixture and placement of concrete and curing so completed concrete surfaces will require no patching.
- B. Defective concrete and honeycombed areas shall be repaired as directed by the ENGINEER.
- C. As soon as forms have been removed and the concrete surfaces exposed, fins and other projections shall be removed. All exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. The CONTRACTOR, at their own expense, shall promptly execute all repairs and replacements herein specified.
- D. Defective surfaces to be repaired as specified in Paragraph C shall be cut back from true line a minimum depth of ½-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for the repair proposed shall contain such proportion of Atlas white Portland Cement as is required to make the color of the patch match the color of the surrounding concrete.
- E. Recesses left by the removal of form ties shall be filled. Immediately after removal of forms, remove plugs and break off metal ties as required by Section 03100. Promptly fill holes upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- F. Surface defects which do not impair structural strength shall be repaired. When patching exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with fine Carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.
- G. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.11 SCHEDULE

- A. The following (Table 3) are the general applications for the various concrete classes and design strengths.

Table 3
Concrete Schedule

Class	Design Strength	Description
A	2,500	Concrete fill and duct encasement
B	3,000	Concrete overlay slabs and pavements
C	N/A	Not used
D	4,500	Walls, slabs on grade, suspended slab and beam systems, grade beams and all other structural concrete

END OF SECTION

SECTION 3360
SHOTCRETE AND WALL DRAINAGE

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Description - Shotcrete placement and wall drainage work shall consist of furnishing all materials and labor required for placing and securing geocomposite drainage material, connection pipes, footing drains, weep holes, drainage gutter, reinforcing steel, nail head bearing plates, nuts and shotcrete for the soil nail walls shown on the plans.
- B. Site Information - The Contractor shall satisfy himself as to the nature and quantity of materials to be moved and other work to be performed, and any differences between site conditions shown on the drawings and actual conditions immediately prior to commencement of work.
- C. Work shall conform to all requirements of ACI 506.2-13 "Specification for Shotcrete" published by the American Concrete Institute, except as modified by this Specification.

1.02 DEFINITION

Shotcrete: Mortar or concrete pneumatically projected at high velocity onto a surface; also known as air-blown mortar; also pneumatically applied mortar or concrete, sprayed mortar and gunned concrete.

1.03 SUBMITTALS

- A. Certified shotcrete mix design including, but not limited to:
 - 1. Brand and type of portland cement.
 - 2. Source, gradation, and quality of all aggregates used.
 - 3. Proportions of mix by weight and water-cement ratio.
 - 4. Proposed admixtures, manufacturer, dosage, technical literature (where allowed).
 - 5. Compressive strength test results for the proposed shotcrete mix design, manufacturer records completed within 6 months of the start of shotcreting may be submitted for initial verification of the required compressive strengths at the start of production work.
- B. Shop Drawings: Reinforcing Steel.
- C. Two 300 mm x 300 mm x 25 mm (12 inch by 12 inch by 1 inch) sample panels showing required finish. Submit panels within 30 days after receipt of notice to proceed.
- D. Written documentation of project references, including project name, owner's name, and phone numbers from at least 3 comparable projects in the last 2 years.
- E. Written documentation of the nozzleman's qualifications including proof of ACI certification (if applicable).
- F. Written documentation of the shotcrete supervisors experience, including direct shotcrete application experience on comparable projects.
- G. Written documentation of the certification of the testing laboratory. Include documentation that the strength testing laboratory complies with ASTM C 1077 and has the experience to

perform the tests specified in this Section. The testing laboratory shall be AASHTO accredited for ASTM C 1077 or demonstrate the ability to perform the requisite tests.

- H. Proposed methods of shotcrete placement and of controlling shotcrete thickness and maintaining facing alignment and location.
- I. Description of the proposed equipment for mixing and applying shotcrete. Include the manufacturer instructions, recommendations, literature, performance, and test data.
- J. Manufactures' data and specifications for geo-composite strip drainage panels, connectors, outlet pipe and all material used for the wall drainage system as shown on the plans or as specified by Engineer.

1.04 QUALITY CONTROL

A. Contractor Qualifications.

1. The work defined in this section is specialty construction requiring a specialty contractor who is highly knowledgeable and experienced in the fabrication and installation of shotcrete. The Contractor performing the work in this Section shall submit proof of three (3) projects within the last five (5) years on which the Contractor has successfully installed shotcrete of similar applications as required for this project. A brief description of each project with the owner's name and phone number shall be included.
2. Workers, including foreman, nozzleman, and delivery equipment operators, shall be fully qualified to perform the work. All nozzlemen on this project shall have at least one year of experience in the past three years in similar shotcrete application work and shall demonstrate ability to satisfactorily place the material.
3. Initial qualification of the nozzlemen shall be based either on ACI certification or satisfactory completion of preconstruction test panels. The requirement for nozzlemen to shoot preconstruction test panels will be waived for nozzlemen who can submit documented proof that they have been certified as an ACI Shotcrete Nozzleman by the American Concrete Institute as outlined in ACI Publication CP-60, and that their certification is current. The Certification shall have been done by an ACI recognized shotcrete testing laboratory, or recognized shotcreting consultant, and shall have covered the type of shotcrete used for the project. Nozzlemen who are not required to shoot preconstruction test panels on the basis of ACI Certification shall still be required to shoot production test panels periodically during the course of the Work at the frequency specified herein.
4. The Contractor shall notify the Engineer not less than 5 days prior to the shooting of preproduction test panels by non-certified nozzlemen. Preproduction test panels shall be prepared using the same shotcrete mix and equipment as those to be used in the production work.
5. The Contractor shall notify the Engineer of any problem that may influence the quality of the shotcrete.

B. Tolerances:

1. Cover of reinforcement: as shown on the plans.
2. Alignment and thickness of shotcrete shall be controlled by installing ground wires. Alignment and thickness control shall conform to ACI 506R Section 5.6.

1.05 PRECONSTRUCTION TESTING

- A. Conform to the requirements of ACI 506R, Paragraph 6.4.
- B. Each nozzleman without previous ACI certification shall make 2 test panels for each mix design, 600 mm (24 inches) square and 90 mm (3 1/2 inches) minimum thickness. Take 5 cores or cubes from each 75 mm (3 inch) panel for compressive strength testing in accordance with ACI 506.2.
- C. Qualification of the nozzlemen shall also be based on a visual inspection of the shotcrete density and void structure and on achieving the specified 3-day and 28-day compressive strength requirements determined for test specimens extracted from the preconstruction test panels. Preconstruction and production test panels, core extraction and compressive strength shall be conducted in accordance with ACI 506.2 and AASHTO T24/ASTM C42, unless otherwise specified herein.
- D. Nozzlemen who are qualified on the basis of preproduction testing may begin production shooting on the basis of acceptable preconstruction test panels and on test specimens passing the 3-day strength requirements. Continued qualification will be subject to test specimens passing the 28-day strength tests and maintaining satisfactory shooting performance during production test panels.
- E. Using the proposed mix design make at least two job-site sample panels approximately 2400 mm (8 feet) high and 1800 mm (6 feet) wide with thicknesses shown. The job-site panels shall contain reinforcing typical of the work to be installed and other details to simulate actual job conditions. Finish sample panels as required for work to be installed. Sample panels must be approved by the Resident Engineer before any work can begin.

1.06 CONSTRUCTION TESTING

Make one test panel 300 mm (12 inches) square and 150 mm (6 inches) thick for each day's work or portion thereof. Provide test panels to a testing laboratory approved by Resident Engineer and reimbursed by the contractor. Four compressive strength specimens will be obtained from each panel and tested for compressive strength in accordance with ASTM C42. One sample is to be tested at 3, 7 and 28 days after application. If the 28 day break exceeds the design strength, then the fourth sample should be broken at 28 days for evaluation of average 28 day strength. If the 28 day break does not exceed the design strength, then the fourth sample should be broken at 56 days. Strength test results are to be reported to the Resident Engineer 24 hours after completion of test.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Portland Cement: ASTM C150, Type II.

- B. Steel Reinforcement:
1. Reinforcing bars below elevation +10 feet shall be ASTM A615, Grade 60, deformed
 2. Reinforcing bars above elevation +10 feet shall be ASTM A775, epoxy-coated, Grade 60, deformed bars
 3. Welded wire reinforcement shall be ASTM 1064, minimum yield strength of 60 ksi
- C. Aggregate: ASTM C33, and UACE EM 1110-2 (Gradation Table 3-1), as defined in Table 2.

TABLE 2 -- GRADATION LIMIT FOR AGGREGATES

Sieve Size, U.S. standard square mesh	Percent by Weight Passing Individual Sieves		
	Gradation No. 1	Gradation No. 2	Gradation No. 3
20 mm 3/4 inch	---	---	100
13 mm 1/2 inch	---	100	80-95
10 mm 3/8 inch	100	90-100	70-90
No. 4	95-100	70-85	50-70
No. 8	80-100	50-70	35-55
No. 16	50-85	35-55	20-40
No. 30	25-60	20-35	10-30
No. 50	10-30	8-20	5-17
No. 100	2-10	2-10	2-10

- D. Chemical Admixtures: ASTM C494.
- E. Air-entraining Admixture: ASTM C260.
- F. Water: Fresh, Clean, and Potable

2.01 MIXES

- A. Shotcrete: The shotcrete used shall consist of a mixture of Portland cement, sand, aggregate, and water so proportioned and mixed to be pumped. Shotcrete shall have a minimum compressive strength of 2000 pounds per square inch at 3-days and 4000 psi at 28-days or as shown on the plans, whichever is greater. No shotcrete work shall be performed prior to verification by the Engineer of the required compressive strength.
- B. Mix Design: Testing Laboratory, retained by Contractor, shall design a mix to produce concrete as specified and perform tests as required. Certified test reports (duplicate) shall be submitted. Reports shall include proportions of design mix.
- C. Maintain water-cement ratio between 0.35 to 0.50 by weight.
- D. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and

obtain approval from the Resident Engineer of proposed changes to concrete-mix design.

- E. Improper Mix: Immediately notify the Concrete Testing Laboratory and the Resident Engineer if at any time during construction the accepted mix design proves to be unsatisfactory for any reason. The Contractor's Concrete Mix Designer shall modify the design, subject to the review of the Resident Engineer, until a satisfactory mix is obtained.

PART 3 – EXECUTION

3.01 WALL DRAINAGE NETWORK

- A. Install and secure all elements of the wall drainage network as shown on the plans or as required by the Engineer to suit field conditions. The drainage network shall consist of installing geocomposite drain strips, connectors and weep holes. All elements of the drainage network shall be installed prior to shotcreting.
- B. Install composite drain strips centered between the column of nails as shown on the plans. The drain strips shall be at least 450 mm (18 inches) wide and placed with the geotextile side against the ground. The wall excavation should be notched into the ground at the panel locations so that the drainage panels do not protrude into the wall as dimensioned on the plans. Secure the strips to the excavation face and prevent shotcrete from contaminating the ground side of the geotextile. Drain strips shall be continuous. Splices, if approved by the Engineer, shall be made with a minimum 300 mm (12 inches) overlap such that the flow of water is not impeded. Repair any damage to the geocomposite drain strips prior to shotcrete placement.
- C. Install connector panels and lower footing drainage panels as shown on the plans. Weep holes should be provided through the shotcrete facing to drain water from behind the wall. Use schedule 40 pvc pipe to form the weep hole through the wall. Prevent shotcrete intrusion into the discharge end of the pipe.

3.02 SHOTCRETE PROPORTIONING, DELIVERING AND MIXING

- A. Proportioning: Mix shall be designed by Contractor-retained testing laboratory; see "PRECONSTRUCTION TESTING" hereinbefore.
- B. Mixing Processes:
 - 1. Mixing, General: Strength of mix is specified on the drawings. At Contractor's option, use either the dry or wet mix process. Discharge entire batch before recharging. Clean mixer at least once every 8-hour shift or portion thereof. Reject material mixed and standing for 45 minutes; remixing or tempering not permitted.
 - 2. Wet Mix Process: Conform to ACI 506R, Paragraph 1.5.2.

3.03 EQUIPMENT, WET MIX PROCESS

- A. Batching and Mixing Equipment: ACI 506R, Paragraph 3.5. Batch by weighing; use rotating mixing equipment and mix in accordance with ACI 304R, and ASTM C94 for ready-mixed concrete.

- B. Delivery Equipment: Use pneumatic feed or positive displacement type of design and size capable of delivering premixed materials accurately, uniformly and continuously through the hose, all in accordance with ACI 506R, Paragraphs 3.3 and 3.7.
- C. Air Supply: ACI 506R, Paragraph 3.4.2.
- D. Water Supply: Conform to ACI 506R, Paragraph 3.8.1 with adequate capacity to maintain water pressure approximately 65 N (15 pounds) higher than highest air pressure required, both air and water pressure uniformly steady, non-pulsating.

3.04 ALIGNMENT CONTROL

- A. General: To establish thickness and surface planes or shotcrete build-up provide ground wires, taut, secure, true to line and plane, conforming to ACI 506R, Paragraph 5.6.
- B. The Contractor shall ensure that the thickness of shotcrete satisfies the minimum requirements shown on the Contract Drawings. Shotcrete shall completely encase all reinforcement and other obstructions shown on the plans. Shotcrete shall be applied by the wet-mix process only.
- C. The Contractor shall ensure that the front face of the shotcrete remains less than 25 mm (1 inch) outside of its required limits shown on the Contract Drawings.
- D. The Contractor shall ensure that the excavated face be flat and free from irregularity prior to shotcrete placement. Additional shotcrete used to fill gaps, voids and irregularities on the excavation face is the responsibility of the Contractor.
- E. The cost of additional material used to fill void space between the actual shotcrete face and the proposed limits of the shotcrete face is the responsibility of the Contractor.
- F. Reinforcing Positioning: Check that reinforcing is positioned and sized in accordance with the Contract Documents and ACI 506R, Paragraph 5.4.

3.06 SHOOTING

- A. General: ACI 506R, Paragraph 8.5.7. Shoot and fill corners first, with continuous uniform material flow from nozzle held approximately 600 to 1500 mm (2 to 5 feet) from the work, at angle normal to the surface.
 - 1. Shoot around reinforcing with nozzle close to encase reinforcement as illustrated in ACI 506R, Figure 8.4, left column.
 - 2. If flow is not uniform and slugs, sand spots or wet sloughs result, turn nozzle away until faulty work is cut out and repaired.
 - 3. Do no shotcrete work if temperature is below 4 degrees Celsius (40 degrees Fahrenheit) without providing continuous heat and adequate protection from freezing.
 - 4. Shotcrete shall be placed in two, successive lifts. Furthermore, each lift shall be 4 inches thick except that for the second lift, the thickness shall be increased to 8

inches where necessary to cover the protruding soil nails. Each lift shall fully encase the applicable welded wire fabric reinforcing layer and reinforcing bars as shown on the plans. The second layer shall also receive an architectural surface treatment and stain.

- B. Preparation of Surfaces to Receive Shotcrete: ACI 506R, Paragraph 5.2, as applicable to the work, as approved.
- C. Rebound: ACI 506R, Paragraph 8.5.11. Do not work rebound into construction nor salvage rebound for subsequent batching.
- D. Suspend application if:
 - 1. High wind prevents nozzlemen from proper application of material.
 - 2. Weather approaches freezing and shotcrete cannot be protected.
 - 3. Rain, other than a very light sprinkle, occurs which would wash cement out of freshly placed material.
 - 4. Ground water or surface water flow is persistent enough to wash cement out of freshly placed material.
- E. Time Between Coats:
 - 1. In sloping, vertical or overhanging work, allow interval of time sufficient for initial, but not final, set to develop.
 - 2. At development of initial set, lightly broom surface to remove any laitance to provide better bond with succeeding applications.
- F. Construction Joints:
 - 1. ACI 506R, Paragraph 5.7.2, tapering over a width of 300 mm (1 foot) to a 25 mm (1 inch) edge from board laid flat.
 - 2. Before proceeding with additional shotcrete work, thoroughly clean joint and adjacent shotcrete, then wet and scour surfaces with air jet.
- G. Warm Weather Application: Prevent dryout resulting in cracking and separation by keeping surfaces continuously moist and/or covered with continuously moistened burlap for 7 days after shotcreting.
- H. Surface Finish: Bring final surfaces of shotcrete to an even plane, well formed corners either square or to radius shown, working up to ground wires using somewhat lower placing velocity than normal.
 - 1. Remove ground wires to 20 mm (3/4 inch) back from surface and fill holes with shotcrete to adjacent surface elevations.
 - 2. Wood float surfaces to provide a smooth true finish.

3.07 CURING - ACI 506.2, Paragraph 3.6.

3.08 HOT WEATHER SHOTCRETING - ACI 506R, Paragraph 8.9.

3.09 COLD WEATHER SHOTCRETING - ACI 506R, Paragraph 8.10.

3.10 PROTECTION AND CLEANUP

- A. Protection: Protect adjacent walls, windows, doors, other building surfaces, grounds and/or shrubs and property of others from damage by shotcreting, rebound and dust.
 - 1. Construct a sealed dust partition to confine rebound and dust to immediate work area. Dust partition shall be integral with exhaust system. A negative air pressure shall be maintained within partitioned area during shotcrete applications to prevent dust leakage beyond area.
 - 2. Immediately clean all shotcrete materials and remove all rebound from site.
- B. Clean-up: Continuously remove rebound material to ensure that base, intermediate, and finish surfaces are clean and ready for bonding layers.

4.01 ARCHITECTURAL SURFACE TREATMENT AND COLORING

- A. All shotcrete surfaces shall receive architectural surface treatment that conform to the details shown on the plans, the provisions in Section 53, "Shotcrete," and Section 51, "Shotcrete Structures," of the Standard Specifications and these special provisions.
- B. If applicable, the exterior surface of the subject soil nail wall shall be "sculpted" and color stained such that the final product is similar to that of natural, fractured local bedrock.
- C. For sculpted shotcrete, the final surface shall be prepared for staining by pressure washing to remove all loose material, laitance, efflorescence, sheen and other foreign materials. No sandblasting will be allowed.
- D. For stained shotcrete, application of the stain base shall be by air or airless sprayer, highlight coloration shall be by staining or other suitable antiquating method. The stain material shall be applied in accordance with the printed instructions of the stain material manufacturer. A copy of such printed material shall be furnished to the Engineer prior to application of the material. The stain material shall produce a spectrum of brown earth tone colors. Color hardeners shall be used to achieve a wider variety of earth tones. Colors shall be such that alteration of the color and further color development after initial application can be accomplished.

5.01 DEFECTIVE WORK

General work will be evaluated by the Engineer or designated agent in accordance with ACI 506.4. If the evaluation reveals unbonded work or cores fail to meet specified strengths, or finishes are unsatisfactory, repair such defective work, as approved, without additional cost to the Owner.

END OF SECTION

SECTION 03380– CONCRETE ELECTRICAL DUCT ENCASEMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and place concrete encasement around underground electrical/instrumentation ductwork as shown on the Drawings and as specified herein.

1.2 RELATED WORK

- A. Section 02200, Earthwork.
- B. Section 03150, Concrete Joints and Joint Accessories.
- C. Section 03300, Cast-in-place Concrete.
- D. Furnishing and Installing Electrical Ducts and Conduits is included in Division 16.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

- A. Concrete shall be measured, mixed and placed, and compacted as required in Section 03300 for Class A concrete and as specified below.
- B. Add 8 pounds of red coloring pigment per cubic yard of concrete.
- C. Provide not less than 3-in of concrete between the outside of a duct and the earth. Provide not less than 3-in of concrete between adjacent ducts.
- D. All duct line concrete pours shall be continuous between manholes or handholes and between manholes or handholes and structures.
- E. Where duct lines pass through concrete walls, concrete envelopes shall be extended through and finished flush with inside surfaces and finished as indicated on the Drawings. Construction joints as shown on the Drawings shall be provided.
- F. All duct encasements shall be reinforced with concrete reinforcement complying with Section 03200.
- G. Duct lines shall be laid in trenches on mats of Class 2 aggregate base not less than 6-in thick and well graded.
- H. The minimum top cover for duct banks shall be 24-in.

END OF SECTION

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SECTION 03600 – GROUT

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.
- B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the ENGINEER but engaged by and at the expense of the OWNER.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork.
 - 2. Section 03150, Concrete Joints and Joint Accessories.
 - 3. Section 03200, Concrete Reinforcement.
 - 4. Section 03300, Cast-in-Place Concrete.
 - 5. Section 03740, Modifications and Repair to Concrete.
 - 6. Section 05500, Miscellaneous Metals.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM)
 - 1. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes.
 - 2. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes.
 - 3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
 - 4. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 5. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
- B. US Army Corps of Engineers (CRD)
 - 1. CRD-C 621 - Corps of Engineers Specification for Nonshrink Grout.

- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, submittals including the following:
 - 1. Commercially Manufactured Nonshrink Cementitious Grout – product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Safety Data Sheet.
 - 2. Commercially Manufactured Nonshrink Epoxy Grout– product data including catalogue cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Safety Data Sheet.
 - 3. Concrete Grout – the submittal shall include data as required for concrete as delineated in Section 03300 and for fiber reinforcement as delineated in Section 03200. This includes the mix design, constituent quantities per cubic yard and the water/cementitious ratio.
- B. Samples:
 - 1. Samples of commercially manufactured grout products when requested by the ENGINEER.
 - 2. Aggregates for use in concrete grout when requested by the ENGINEER.
- C. Laboratory Test Reports:
 - 1. Submit laboratory test data as required under Section 03300 for concrete to be used as concrete grout.
- D. Certifications:
 - 1. Certify that the CONTRACTOR is not associated with the independent testing laboratory, nor does the CONTRACTOR or its officers have a beneficial interest in the laboratory.

1.5 QUALITY ASSURANCE

- A. Qualifications – Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.
- B. Pre-Installation Conference – Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.
- C. Services of Manufacturer's Representative – A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each

type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.

- D. Field Testing – The field testing of Concrete Grout shall be as specified for concrete in Section 03300.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to six months or the manufacturer's recommended storage time, whichever is less.
- C. Material that becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the OWNER.
- D. Nonshrink cement-based grouts shall be delivered as pre-blended, prepackaged mixes requiring only the addition of water.
- E. Nonshrink epoxy grouts shall be delivered as pre-measured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.7 DEFINITIONS

- A. Nonshrink Grout – A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2 PRODUCTS

2.1 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

- A. Nonshrink Cementitious Grout:
 - 1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD-C 621. Grouts shall be Portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827. The minimum 28-day compressive strength of 5,000 psi is required for all non-shrink cementitious grout.

2. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; NS Grout by The Euclid Chemical Co.; FSP Construction Grout by Five Star Products Inc.; or equal.
3. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by BASF Building Systems; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout, by Five Star Products Inc.; or equal.

B. Non-Shrink Epoxy Grout:

1. Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a minimum compressive strength of 10,000 psi in seven days when tested in accordance with ASTM C579, Method B, and have a maximum thermal expansion of 30×10^{-6} when tested in accordance with ASTM C531. The grout shall be Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Star Products, Inc.; Sikadur 42 Grout-Pak by Sika Corp.; E3-HP by the Euclid Chemical Co.; or equal.

C. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03300 except as specified herein. It shall be proportioned with cement, [pozzolan], coarse and fine aggregates, water, and water reducer to produce a mix having an average strength of 2900 psi at 28 days, or 2500 psi nominal strength. Coarse aggregate size shall be $3/8$ [1/2]-in maximum. Slump shall not exceed 5-inches and should be as low as practical yet still retain sufficient workability.
2. Synthetic reinforcing fibers as specified in Section 03200 shall be added to the concrete grout mix at the rate of 1.5-pounds of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

D. Water:

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. Use of reclaimed or recycled water is not permitted.

PART 3 EXECUTION

3.1 PREPARATION

- A. Grout shall be placed over cured concrete that has attained its full design strength unless otherwise approved by the ENGINEER.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular

voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oil less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of base-plates prior to the installation of the grout.
- E. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- F. Construct grout forms or other leak proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
 1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- G. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- H. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the ENGINEER.

3.2 INSTALLATION – GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and until grout compressive strength reaches 1000 psi or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of base plates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.
- E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.
- F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.3 INSTALLATION – CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

- A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the ENGINEER.
- B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C. Placements greater than 3-in in depth shall include the addition of clean washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- E. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the ENGINEER. Finish this surface with a wood float (brush) finish.
- F. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.4 INSTALLATION – NONSHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.
- C. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.5 INSTALLATION – CONCRETE GROUT

- A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of the concrete grout.
- B. Remove the debris and clean the surface by sweeping and vacuuming all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.
- C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the ENGINEER. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. [(A bonding agent composed of 1 part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)]
- D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.
- E. Provide grout control joints as indicated on the Drawings.
- F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.6 SCHEDULE

- A. General purpose nonshrink cementitious grout: Use at all locations where nonshrink grout is called for on the Drawings except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.
- B. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable nonshrink grout on the Drawings. The CONTRACTOR, at his/her option and convenience, may substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.
- C. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade.

END OF SECTION

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SECTION 03740 – MODIFICATIONS AND REPAIR TO CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required to cut, remove, repair or otherwise modify parts of existing concrete structures as shown on the Drawings and as specified herein as necessary to complete the Work. Work under this Section shall also include bonding new concrete to existing concrete.

1.2 RELATED WORK

- A. Related Work Specified Elsewhere:
 - 1. Section 03100, Concrete Formwork.
 - 2. Section 03150, Concrete Joints and Joint Accessories.
 - 3. Section 03200, Concrete Reinforcement.
 - 4. Section 03300, Cast-in-Place Concrete.
 - 5. Section 03600, Grout.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM)
 - 1. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 2. ASTM C882 - Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
 - 3. ASTM C883 - Test Method for Effective Shrinkage of Epoxy-Resin Systems Used with Concrete.
 - 4. ASTM D570 - Test Method for Water Absorption of Plastics.
 - 5. ASTM D638 - Standard Test Method for Tensile Properties of Plastic.
 - 6. ASTM D695 - Test Method for Compressive Properties of Rigid Plastic.
 - 7. ASTM D732 - Standard Test Method for Shear Strength of Plastics by Punch Tool.
 - 8. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced Plastic and Electrical Insulating Materials.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. All submittals shall be in accordance with Division 1.
- B. Submit manufacturer's technical literature on all product brands proposed for use by the CONTRACTOR, to the ENGINEER for review. The submittal shall include the manufacturer's installation and/or application instructions.
- C. When substitutions for acceptable brands of materials specified herein are proposed by the CONTRACTOR, submit brochures and technical data of the proposed substitutions to the ENGINEER for approval before delivery to the jobsite.

1.5 QUALITY ASSURANCE

- A. No existing structure or concrete shall be shifted, cut, removed, or otherwise altered until authorization is given by the ENGINEER.
- B. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers, shoring and bracing and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work, protect personnel, control dust and to prevent damage to the structures or contents by falling or flying debris. Unless otherwise permitted, shown or specified, line drilling will be required in cutting existing concrete.
- C. Manufacturer qualifications: The manufacturer of the specified products shall have a minimum of ten years experience in the manufacture of such products and shall have an ongoing program of training, certifying and technically supporting the CONTRACTOR's personnel.
- D. Contractor qualifications: Contractors shall complete a program of instruction in the application of the approved manufacturer's material specified in this Section and provide certification from the manufacturer attesting to their training and status as an approved applicator.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Materials shall comply with this Section and any applicable State or Local requirements.

2.2 MATERIALS

A. Epoxy Bonding Agent:

1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive epoxy resin material used to bond plastic concrete to hardened concrete complying with the requirements of ASTM C881, Type II.
2. Color shall be concrete gray.
3. Product shall be Sikadur 32 Hi-Mod by Sika Corporation; Concrese Liquid LPL by BASF Building Systems; or approved equal.

B. Epoxy Paste:

1. Epoxy paste shall be a two-component, solvent-free, moisture insensitive epoxy resin material used to bond dissimilar materials to concrete such as setting railing posts, dowels, anchor bolts, and all-thread rods into hardened concrete and shall comply with the requirements of ASTM C881, Type I, Grade 3. It may also be used to patch existing surfaces where the glue line is 1/8-in or less.
2. Color shall be concrete gray.
3. Product shall be Sikadur 31 Hi-Mod Gel by Sika Corporation; Concrese Paste LPL by BASF Building Systems; or approved equal.

C. Nonshrink Grout and Nonshrink Epoxy Grout shall be as specified in Section 03600.

D. Adhesive anchors shall be as specified in Section 05500.

E. Crack Repair Epoxy Adhesive:

1. Crack Repair Epoxy Adhesive shall be a two-component, solvent-free moisture insensitive epoxy resin material suitable for crack grouting by injection or gravity feed. It shall be formulated for the specific size of opening or crack being injected.
2. For standard applications, product shall be Sikadur 35 Hi-Mod LV by Sika Corporation; SCB Concrese 1380 by BASF Building Systems; or approved equal.

PART 3 EXECUTION

3.1 GENERAL

- A. Cut, repair, reuse, demolish, excavate or otherwise modify parts of the existing structures, as indicated on the Drawings, specified, or necessary to permit completion of the Work. Finishes, joints, reinforcements, sealants, etc. are specified in other Sections of this Specification. All work shall comply with other requirements of this Section and as shown on the Drawings.
- B. All commercial products specified in this Section shall be stored, mixed, and applied in strict compliance with the manufacturer's recommendations.

- C. In all cases where concrete is repaired in the vicinity of an expansion joint or control joint the repairs shall be made to preserve the isolation between components on either side of the joint.
- D. When drilling holes for dowels/bolts at new or existing concrete, drilling shall stop if rebar is encountered. As approved by the ENGINEER, the hole location shall be relocated to avoid rebar. The CONTRACTOR shall not cut rebar without prior approval. Where possible, rebar locations shall be identified prior to drilling using "rebar locators" so that drilled hole locations may be adjusted to avoid rebar interference.
- E. When coring new openings at new or existing concrete, the CONTRACTOR shall identify existing rebar locations using "rebar locators". Where possible and as approved by the ENGINEER, the CONTRACTOR shall locate the new hole to avoid and/or minimize rebar interference. The CONTRACTOR shall not cut existing rebar without prior approval from the ENGINEER.

3.2 CONCRETE REMOVAL

- A. Concrete designated to be removed to specific limits as shown on the Drawings or directed by the ENGINEER, shall be done by line drilling at limits followed by chipping or jack-hammering as appropriate in areas where concrete is to be taken out. Remove concrete in such a manner that surrounding concrete or existing reinforcing to be left in place and existing in place equipment is not damaged. Sawcutting at limits of concrete to be removed shall only be done if indicated on the Drawings, or after obtaining written approval from the ENGINEER.
- B. Where existing reinforcing is exposed due to saw cutting/core drilling and no new material is to be placed on the saw cut surface, a coating or surface treatment of epoxy paste shall be applied to the entire cut surface to a thickness of 1/4-in.
- C. In all cases where the joint between new concrete or grout and existing concrete will be exposed in the finished work, except as otherwise shown or specified, the edge of concrete removal shall be a 1-in deep saw cut on each exposed surface of the existing concrete.
- D. Concrete specified to be left in place that is damaged by the CONTRACTOR shall be repaired by approved means to the satisfaction of the ENGINEER and at no additional cost to the OWNER.
- E. The ENGINEER may from time to time direct the CONTRACTOR to make additional repairs to existing concrete. These repairs shall be made as specified or by such other methods as may be appropriate.

3.3 CONNECTION SURFACE PREPARATION

- A. Connection surfaces shall be prepared as specified below for concrete areas requiring patching, repairs or modifications as shown on the Drawings, specified, or as directed by the ENGINEER.
- B. Remove all deteriorated materials, dirt, oil, grease, and all other bond inhibiting materials from the surface by dry mechanical means, i.e. - sandblasting, grinding, etc., as approved by the ENGINEER. Surfaces shall be roughened to a full amplitude of at least 1/2-in in depth. Irregular voids or surface stones need not be removed if they are

sound, free of laitance, and firmly embedded into parent concrete, subject to the ENGINEER's final inspection.

- C. If reinforcing steel is exposed, it must be mechanically cleaned to remove all contaminants, rust, etc., as approved by the ENGINEER. If half of the diameter of the reinforcing steel is exposed, chip out behind the steel. The distance chipped behind the steel shall be a minimum of 1/2-in. Reinforcing to be saved shall not be damaged during the demolition operation.
- D. Reinforcing from existing demolished concrete that is shown to be incorporated in new concrete shall be cleaned by mechanical means to remove all loose material and products of corrosion before proceeding with the repair. It shall be cut, bent or lapped to new reinforcing as shown on the Drawings and provided with one-inch minimum cover all around.
- E. The following are specific concrete surface preparation and connection "methods" to be used where called for on the Drawings, specified or as directed by the ENGINEER.
 - 1. Method A - After the existing concrete surface at the connection has been roughened and cleaned, thoroughly saturate and maintain saturation for a period of at least 12 hours. Brush on a 1/16-in layer of cement and water mixed to the consistency of a heavy paste. Immediately after application of cement paste, place new concrete or grout mixture as detailed on the Drawings.
 - 2. Method B – After the existing concrete surface has been roughened and cleaned, apply epoxy-bonding agent at connection surface. The field preparation and application of the epoxy-bonding agent shall comply strictly with the manufacturer's recommendations. Place new concrete or grout mixture to limits shown on the Drawings within time constraints recommended by the manufacturer to ensure bond.
 - 3. Method C - Adhesive anchors shall be set in existing concrete by drilling holes to the required depth to develop the full tensile and shear strengths of the anchor material being used. The adhesive anchor system shall be installed per the manufacturer's recommendation in holes sized as required. Unless otherwise shown on the Drawings, deformed bars shall be drilled and set to a depth of ten bar diameters and smooth bars shall be drilled and set to a depth of 15 bar diameters. The anchor may be installed in horizontal, vertical and overhead positions as indicated on the Drawings. The allowable tensile value for anchors installed in overhead positions shall be limited to 50% of the ICC ES published allowable value.
 - 4. Method D - Combination of Method B and C.

3.4 GROUTING

- A. Grouting shall be as specified in Section 03600.

3.5 CRACK REPAIR

- A. Cracks on horizontal surfaces shall be repaired by gravity feeding crack repair adhesive into cracks per manufacturer's recommendations. If cracks are less than 1/16-in in thickness they shall be pressure injected.

- B. Cracks on vertical surfaces shall be repaired by pressure injecting crack repair adhesive through valves sealed to the surface with crack repair epoxy adhesive per manufacturer's recommendations.

END OF SECTION

SECTION 05120 – STRUCTURAL STEEL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Erection and completion of all structural steel, including all bracing and shoring required for erection and related work. The work shall include and not necessarily be limited to the following:
 - 1. Structural steel, including but not limited to columns, girders, trusses, beams, girts, bracing, anchor bolts, base plates, connection bolts, etc.
 - 2. Anchor bolts shall be furnished under this section and set under Section 03300. Furnish anchor bolts, nuts and metal setting templates. Furnish instructions for the setting of anchor bolts and ascertain that the items are properly set during and after the progress of the work. Verify anchor bolt setting to assure adequate fit of the steel work.
 - 3. For grouting of base plates, see Section 03600.
 - 4. For painting of hot-dipped galvanized elements (duplex system) see Section 09970 – Shop Painting of Hot Dipped Galvanized Steel.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03600, Grout
- B. Section 05210, Steel Joists
- C. Section 05310, Steel Roof Deck
- D. Section 05500, Miscellaneous Metals
- E. Section 09960, Protective Coating
- F. Section 09970 – Shop Painting of Hot-Dipped Galvanized Steel

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Federal Specifications:
 - 1. DOD-P-21035 Paint, High Zinc Dust Content, Galvanizing Repair.
 - 2. MIL-P-26915 Primer Coating, Zinc Dust Pigment.
- B. American Institute of Steel Construction (AISC):
 - 1. AISC S302 Code of Standard Practice for Steel Buildings and Bridges.

2. AISC S335 Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design Commentary.
3. AISC M016 Manual of Steel Construction Allowable Stress Design.

C. ASTM International (ASTM):

1. ASTM A36 Standard Specification for Carbon Structural Steel.
2. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A123 Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
4. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A307 Standard Specification for Carbon Steel Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
6. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
7. ASTM A780 Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dipped Galvanized Coating.
8. ASTM A992 Standard Specification for Structural Steel Shapes.
9. ASTM B695 Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
10. ASTM D6386 Standard Practice for Preparation of Zinc (Hot-Dipped Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
11. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

D. American Welding Society (AWS):

1. AWS A5.1 Specifications for Carbon Steel Electrodes for Shielded Metal Arc Welding.
2. AWS D1.1 Structural Welding Code Steel.

E. Research Council on Structural Connections of the Engineering Foundation (RCSCEF):

1. Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 QUALITY ASSURANCE

A. Identification of Steel:

1. CONTRACTOR shall certify, test, and inspect all materials, welding, fabrication and erection in accordance with the requirements of AISC and AWS D1.1.
2. Submit mill analysis and test reports for the steel, certified by the manufacturer, to show material is in conformance with the specified ASTM standard. CONTRACTOR shall identify steel in accordance with CBC Section 2203 as to heat number and furnish the OWNER's Testing Agency, for their review, mill tests and manufacturer's certification for each heat of steel. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards. The cost of such testing shall be paid by the CONTRACTOR.
3. Submit certificates of compliance for welding electrodes indicating material is in conformance with these Specifications.
4. High strength bolts, nuts, washers and threaded rods shall be sampled and tested in accordance with the requirements of the specification for High Strength Bolts for Structural Steel Joints, ASTM A325 or ASTM A490 Bolts.

B. Welding Inspection by the OWNER's Testing Agency: All shop and field welding shall be inspected by an AWS certified welding inspector in accordance with AWS D1.1 Section 6. The OWNER's Testing Agency shall provide the following:

1. Review of CONTRACTOR's Welding Procedure Specifications (WPS) submittal and verify that welders are performing work in accordance with the approved WPS.
2. Verification of welder qualifications.
3. Verification that electrical meters being used accurately reflect voltage and amperage at the welding site for the length of cable in use.
4. Visual Inspection: Visually inspect all welding in accordance with AWS D1.1 Section 6, and including verification of fit-up, preheat, calibration of equipment, equipment settings, materials, adherence to approved WPS, interpass temperatures, deposition rates, technique, proper fusion of each pass, ensure the weld is crack free at each pass, confirm porosity and undercut do not exceed AWS requirements, confirm the final weld profile, and confirm that all special requirements specified herein are adhered to.
5. NDT (non-destructive testing) Ultrasonic Inspection: Test 100% of all complete joint penetration (CJP) groove welds using ultrasonic testing. The ultrasonic instrumentation shall be calibrated by the technician to evaluate the quality of the welds in accordance with AWS D1.1., Section 6.25. Technician who operates the

equipment shall examine the welds and maintain a record of all welds examined, defects found and disposition of each defect. All defective welds shall be repaired by the CONTRACTOR and retested with ultrasonic equipment, at the expense of the CONTRACTOR.

6. NDT (non-destructive testing) Magnetic Particle Inspection: Test 100% of all back-gouged weld roots and 100% of all weld tab removal sites using magnetic particle testing in accordance with ASTM E 709-91. Technician who operates the equipment shall examine the welds and maintain a record of all welds so examined, defects found and disposition of each defect. All defects shall be repaired by the CONTRACTOR and retested at the expense of the CONTRACTOR.

- C. Fabrication and Erection Inspection by the OWNER's Testing Agency: All fabrication and erection of structural steel shall be inspected by the OWNER's Testing Agency. This inspection, in addition to the welding inspection requirements specified herein, shall consist of, but shall not necessarily be limited to, the following:
 1. Visually inspect steel shapes and plates for existence of defects such as laminations and non-metallic inclusions. Use ultrasonic equipment and other NDT methods to determine extent of defects.
 2. Verify steel materials with mill certificates. Verify weld filler metal materials with certificates and manufacturers recommended limitations.
 3. Review rolled shapes for conformity to dimensional standards specified.
 4. Inspect high strength bolting in conformance with the "Specification for Structural Joints using ASTM A325 or A490 Bolts" as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
- D. Welding, fabrication and erection Inspection by the OWNER's Testing Agency as required to satisfy the building code requirements for special inspection will be paid for by the OWNER, unless specifically stated otherwise.
 1. If inspection of shop fabrication requires the OWNER's Testing Agency to travel further than 100 miles from the project site, the full cost of travel expenses incurred for such inspection shall be covered by the CONTRACTOR.

1.5 SUBMITTALS

- A. Mill Test Reports: CONTRACTOR shall furnish certified copies of all mill analysis and test reports covering the chemical and physical properties of the steel for review by the OWNER's Testing Agency.
- B. Certifications:
 1. Certified mill test reports for the structural steel and bolting materials.
 2. Certification that welders are qualified, in accordance with AWS D1.1, on shop and field welding procedures to be used.

C. Shop Drawings:

1. Detailed shop drawings, erection drawings, schedules, and data for all structural steel. Review will be for general conformance with the Contract Documents and shall not relieve the CONTRACTOR of responsibility for proper fit of members, connections not detailed on the Drawings, or for supplying all material required by the Contract Documents. Mark numbers painted on the shop assembled pieces of steel shall be the same mark numbers used on the detailed shop and erection drawings.

D. Welding Procedure Specifications (WPS): CONTRACTOR shall submit welding procedure specifications (WPS) and procedure qualification records (PQR) for all welded joint types.

E. Review of submittals and shop drawings will cover only the general scheme and character of the details, but not the checking of dimensions, nor will such review relieve the CONTRACTOR from responsibility for executing the work in accordance with the Contract Drawings.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials promptly so as to cause no delay with other parts of the Work.
- B. Store materials on skids and not on the ground. Pile and block materials so that they will not become bent or otherwise damaged
- C. Handle materials with cranes or derricks as far as practicable. Do not "dump" steel off cars or trucks, nor handle in any other manner likely to cause damage.
- D. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated into the work. Remove and replace them with new, undamaged materials, at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MATERIALS

- A. Steel Shapes, Plates and Bars: ASTM A36, typical unless otherwise noted.
- B. Steel Wide-Flange Shapes: ASTM A992.
- C. Steel Tubing: ASTM A500, Grade B.

- D. Steel Pipe: ASTM A53, Type S, Grade B.
- E. Arc-Welding Electrodes: Filler metals shall conform to Table 3.1 of AWS D1.1. Electrodes and equipment settings shall be as recommended by the filler metal manufacturer for the position, thickness or other conditions of actual use. All electrodes and filler metals shall be low hydrogen types. Filler metals with the E70-T4 designation shall not be used.
- F. Anchor Bolts: ASTM F1554 Grade 36.
- G. Machine Bolts: ASTM A307.
- H. High-Strength Bolts: ASTM A325, Connection Type X, N or SC, as indicated on the Drawings.
- I. Shop Primer: As specified in Section 09960.
- J. Galvanizing: Per ASTM A123 and ASTM A153.
- K. Galvanized Surface Primer: 95 percent zinc dust, organic vehicle primer.
- L. Duplex System – Galvanizing shall satisfy the requirements of ASTM A123 or A153, as applicable. Water quenching or chromate conversion coating shall be avoided as these processes may interfere with paint adhesion and surface preparation. Refer to Section 09970 – Shop Painting of Hot Dipped Galvanized Steel, for additional information.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

- A. Prepare and shop prime paint non-galvanized members as specified in Section 09960 – Protective Coatings. Do not prime paint faying surfaces of slip critical connections.
- B. Prepare and paint galvanized members as specified in Section 09970 – Shop Painting of Hot-Dipped Galvanized Steel.
- C. Galvanize and paint (duplex system) members and their attachments exposed in whole or part to the weather, including beams supporting exterior masonry. Galvanize and paint other members as indicated on the Drawings. Duplex system shall be done after fabrication and in accordance with ASTM A123. Hardware galvanizing shall be in accordance with ASTM A153. Thoroughly clean, pickle, flux, and immerse members in bath of molten zinc until temperature becomes the same as the bath. Coating shall be 2-oz. per-square-foot.
- D. The CONTRACTOR shall notify the OWNER at least four weeks in advance of surface preparation and painting in the fabricator's shop so that a local independent NACE paint inspector can provide local inspection and dry film testing before the steel leaves the shop. The cost for the independent NACE paint inspector will be paid for by the OWNER.

3.2 GENERAL FABRICATION

- A. Workmanship and details of structural steel work, unless otherwise specified, shall conform to the California Building Code and the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings. The quality of materials and the fabrication of all welded connections shall conform to the American Welding Society's Structural Welding Code, AWS D1.1.
- B. The CONTRACTOR shall secure all field measurements necessary for the completion of this work. The CONTRACTOR shall be responsible for all errors of detailing and fabrication and for the correct fitting of the structural members to each other and to their supports.
- C. Provide bolts and connections for attachment of the work of other sections to the structural steel. Provide column anchor bolts and templates for setting under Section 03300.
- D. All materials both before and after fabrication shall be protected from corrosion and shall be kept free from dirt, grease and other foreign matter.
- E. Each framing member shall be free from twists and bends. Holes and all cut and sheared edges shall be neatly made without kinks, butts and warped edges. All steel left exposed shall be straight, smooth and free of nicks, scars and dents. Exposed welds shall be uniform and neat.
- F. Holes for Bolts: Holes for bolts shall be 1/16 inch larger than the nominal diameter of the bolt. If the thickness of the material is not greater than the nominal diameter of the bolt plus 1/8 inch, the holes may be punched. Holes in thicker material shall be drilled from the solid or sub-punched and reamed. Holes for high-strength bolts shall have all burrs removed by grinding.
- G. Column Bearing Surfaces: Column bases, as required by the AISC specification, and all column bearing surfaces shall be milled to a true plane perpendicular to the axis of the member to assure a complete bearing at the contact face.

3.3 WELDING

- A. All welding shall be performed in strict adherence with an approved, written WPS.
- B. Preparation for Welding: All surfaces shall be clean, free of rust, paint and foreign matter of any kind. Scale shall be removed by wire brush, chipping or hammering as required. Thermal cut edges to be welded shall be chipped clean, and ground at least 1/32 inch to bright metal before welding. Clamp members as required, space and alternate welds, all as may be necessary to prevent warping or misalignment.
- C. Weld Quality: Welds shall present a uniform surface, free of imperfections as defined by AWS, and without undercutting or over-lapping and free of excessive oxides, gas pockets and non-metallic inclusions. Welds shall be made with the proper number of beads or passes to secure sound, thoroughly fused joints. Each deposit shall not exceed maximum layer height and bead width specified in AWS D1.1. Each pass shall

be cleaned by chipping and wire brushing to remove scale and slag, before placing any additional weld metal.

- D. Sequence of Welding: For highly restrained connection and/or weldments, the sequence of welding shall be designed to minimize distortion of the members and to minimize the buildup of internal stresses.
- E. Preheat: No welding at the joint may proceed, including tack welds, backup bars and weld tabs, until the pre-heating has been completed. Preheat base metals in accordance with AWS D1.1 Table 3.2, except the following minimum values shall apply:
1. For restrained welding conditions, minimum preheat shall be determined using AWS D1.1 Annex XI. Restrained welding conditions shall include but are not limited to: Continuity plates in columns.
 2. For all other welds, minimum preheat shall not be less than as tabulated below:

Minimum Preheat – See Note (2) (ASTM A 36 or ASTM A 572-50 Base Metals)	
Base Metal Thickness	Minimum Preheat
Up to 3/4 Inch	None. See Note (1)
Over 3/4 up to 1-1/2 Inch	75°F
Over 1-1/2 up to 2-1/2 Inch	200°F
Over 2-1/2 up to 3-1/2 Inch	300°F
Over 3-1/2 Inch	350°F min
(1) There should be at least enough heat to drive off any moisture. Comply with AWS D1.1, Table 3.2.	
(2) This table shall not be construed as replacing any more stringent requirements found in AWS D1.1. See also footnote 1 of AWS D1.1, Table 3.2	

- A. Interpass Temperature: Minimum interpass temperatures shall be in accordance with the minimum preheat requirements. Maximum interpass temperatures shall not exceed 550°F. Inspector shall measure interpass temperatures during the work. Measurement shall be taken on base metal, not more than 2 inches from the weld.
- B. Special requirements:
1. Technique: Weld passes shall be made using stringer beads only, weaving passes are not permitted. For multi-pass beam-column flange welds, the first pass shall be placed at the column flange and the welding shall proceed towards the beam flange.
 2. Backing Bars: Backing bars, where used, shall be continuous, without butt joints, across the entire width of the joint, including the length of the weld tabs. Unless otherwise noted on the drawings, all backing bars shall be removed by thermal

cutting, the root back-gouged, the root and surrounding base metal ground to remove 1/32 inch of surface material, the prepared groove tested for defects using magnetic particle or dye penetrant testing, the groove rewelded and capped with a fillet weld according to the profile indicated on the drawings but not less than 1/4 inch. The weld metal for the backing fillet weld shall be made using the same process and filler metal as the groove weld.

3. Weld Tabs: Weld tabs shall be used for all groove welds, and shall be in accordance with AWS D1.1. Weld tabs shall be removed upon completion of the weld and the ends of the weld shall be made smooth and ground flush with the abutting parts. The detailed transition of weld material to the base metal shall embody a radius not less than the thickness of the beam flange. Except where end of weld is to be NDT tested, grind surface to AWS C4.1-77 Sample 2 roughness, otherwise grind to a smoothness required by the testing technique to be used. "End Dams" or other devices that are placed perpendicular to the weld axis shall not be used.
4. Weld Access Holes: Connection plates at or near the weld access hole shall be sized to ensure the weld access hole region remains unobstructed. Where weld access holes are made by thermal cutting, the surface of the cut and the surrounding base metal shall be ground at least 1/32 inch to bright metal to remove any martensite.
5. Welding through Weld Access Holes: All passes shall begin at the center of the joint and work towards the ends of the joint, terminating on the Weld Tab. Each weld layer shall be completed on both sides of the beam web before the next weld layer is started.
6. Faulty and Defective Welding: Any welding performed without inspection or contrary to the approved WPS, or showing cracks, slag inclusion, lack of fusion, undercut or other defects as defined by AWS, ascertained by visual or other means of inspection, shall be chipped out and properly replaced by the CONTRACTOR, and reinspected by OWNER's Testing Agency, at the CONTRACTOR's expense.

3.4 ERECTION

- A. Field Connections: Workmanship of field bolted and welded connections shall conform in all respects to methods and tolerances specified for fabrication.
- B. High strength bolted connections shall be made in conformance with the "Specification for Structural Joints using ASTM A325 or A490 Bolts" approved by Research Council on Riveted and Bolted Joints of the Engineering Foundation.
- C. Furnish and install temporary bracing to provide stability during erection and to prevent distortion or damage to the framing due to wind, seismic, or erection forces. Remove temporary bracing when erection is complete.
- D. No final connections shall be made until the structure has been properly aligned. All temporary flooring, planking and scaffolding necessary in connection with the erection of the structural steel, or the support of erection machinery shall be provided as part of

the erection work. The temporary floors and scaffolding shall conform to the requirements of all laws governing safety regulations.

- E. Drifting done during assembly shall not distort the metal or enlarge the holes. Mismatching of holes greater than 3/32 inch shall require reaming for the next larger bolt. Mismatching of holes greater than 1/8 inch shall be cause for rejection.

3.5 DEFECTIVE WORK

- A. Work found to be defective, missing or damaged shall immediately be replaced with proper work. Such replaced work and the inspection for same shall be at the expense of the CONTRACTOR.
- B. Straightening of any material, if necessary, shall be done by a process and in a manner that will not injure the materials, and which is approved by the ENGINEER. Sharp kinks or bends shall be cause for rejection. Heating will not be allowed.
- C. Delamination and other rolling defects in structural shapes and plates shall be cause for rejection when, in the judgment of the ENGINEER, repairs are not feasible or acceptable.
- D. If defects or damaged work cannot be corrected in the field, the material shall be returned to the shop or new parts furnished, as the ENGINEER directs; the CONTRACTOR shall replace all work at his own expense.

END OF SECTION

SECTION 05500– MISCELLANEOUS METALS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03100, Concrete Formwork
- B. Section 03150, Concrete Joints and Joint Accessories
- C. Section 03200, Concrete Reinforcement
- D. Section 03300, Cast-in-Place Concrete
- E. Section 03600, Grout
- F. Section 03740, Modifications and Repair to Concrete
- G. Section 09970, Shop Painting of Hot-Dipped Galvanized Steel
- H. Section 09960, Protective Coatings

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Federal Specifications:
 - 1. DOD-P-21035 – Paint, High Zinc Dust Content, Galvanizing Repair
 - 2. FF-B-575C - Bolts, Hexagonal and Square.
 - 3. MIL-G-18015 A (3) - (Ships) Aluminum Planks (6063-T6)
 - 4. MIL-A-907E - Antiseize Thread Compound, High Temperature.
 - 5. MIL-P-26915 – Primer Coating, Zinc Dust Pigment
- B. Aluminum Association:
 - 1. AA-M32C22A41 - M31 – Mechanical Finish, Fine Satin; C22 – Finish, Medium Matte; A41 – Clear Anodic Coating, Class I
- C. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. Standard Specifications for Highway Bridges – HS20 Truck Loading
- D. American Concrete Institute (ACI):
 - 1. ACI 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete.

- 2. ACI 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete
- E. American Institute of Steel Construction:
 - 1. Steel Construction Manual
- F. American Iron and Steel Institute (AISI):
 - 1. Design of Light Gauge, Cold-Formed Steel Structural Members
- G. ASTM International (ASTM):
 - 1. ASTM A36 - Standard Specification for Carbon Structural Steel
 - 2. ASTM A48 - Standard Specification for Gray Iron Castings
 - 3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - 4. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
 - 5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 6. ASTM A125 - Standard Specification Steel Springs, Helical, Heat Treated.
 - 7. ASTM A153 - Standard Specification Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 8. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - 9. ASTM A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and other Special Purpose Applications.
 - 10. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 11. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
 - 12. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 13. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.
 - 14. ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
 - 15. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

16. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
17. ASTM A536 - Standard Specification for Ductile Iron Castings.
18. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
19. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
20. ASTM A780 – Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dipped Galvanized Coatings.
21. ASTM A786 - Standard Specification for Hot-Rolled Carbon, Low Alloy, High Strength Low Alloy and Alloy Steel Floor Plates.
22. ASTM A992 – Standard Specification for Structural Steel Shapes
23. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, Solution Hardened, Bake Hardenable.
24. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled Carbon, Structural, High Strength Low Alloy and Ultra-High Strength, and High Strength Low Alloy with Improved Formability
25. ASTM B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
26. ASTM B201 – Standard Practice for Testing Chromate Coatings on Zinc and Cadmium Surfaces.
27. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
28. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
29. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
30. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
31. ASTM C633 – Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings.
32. ASTM D6386 – Standard Practice for Preparation of Zinc (Hot-Dipped Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
33. ASTM E140 – Hardness Conversion Tables for Metals
34. ASTM E376 Standard Practice for Measuring Coat Thicknesses by Magnetic-Field or Eddy-Current (Electromagnetic) Examination Methods.

35. ASTM E384 – Micro Hardness of Materials
36. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
37. ASTM F594 – Standard Specification for Stainless Steel Nuts
38. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

H. American Welding Society (AWS)

1. ANSI/AWS D1.1- Structural Welding Code – Steel.
2. ANSI/AWS D1.2 - Structural Welding Code – Aluminum.
3. ANSI/AWS QC1 - Qualification and Certification of Welding Inspectors.

I. National Fire Protection Association (NAFP):

1. NFPA 101 - Life Safety Code.

J. National Association of Architectural Metal Manufacturers (NAAMM)

1. Metal Stairs Manual.

K. National Association of Corrosion Engineers (NACE)

1. Coating Inspector Program (CIP)

L. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Shop Drawings - Shop drawings of all miscellaneous metalwork shall be submitted to the ENGINEER for review in accordance with Division 1.
- B. Layout drawings for grating and/or aluminum plank grating shall be submitted showing the direction of span, type and depth, size and shape of panels, seat angle details, and details of hold down fasteners. Load and deflection tables shall be submitted for each style and depth of grating/plank grating used.
- C. Manufacturer's shop drawings for Pre- Engineered Structure (Canopy), showing dimensions, materials lists, methods of supporting, methods of anchoring, and finishes. Shop drawings shall include, as a minimum, plans elevations, sections, details of components and attachments to other units of the Work.
- D. Welding Procedure Specifications (WPS): Contractor shall submit Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR) for all welding joint types, as applicable.
- E. An ICC-ES report listing the ultimate load capacity in tension and shear for each size and type of post installed concrete anchor used shall be submitted to the ENGINEER

for review. CONTRACTOR shall submit manufacturer's recommended installation instructions and procedures for all mechanical and adhesive anchors for ENGINEER's review. Upon review, by ENGINEER, these instructions shall be followed explicitly.

- F. No substitution for the indicated mechanical and/or adhesive anchors will be considered unless accompanied with ICC-ES report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.
- G. Samples:
 - 1. Submit 12-in-by-12-in samples of metal grating, aluminum plank grating and cover plates, illustrating surface finish, color, texture and jointing details.
 - 2. Submit 12-in long samples of guardrail and handrail. Submit samples of elbow, tee, wall bracket, escutcheon, end stop and rail joint connections.
 - 3. Pre-Engineered Structure (Canopy) – Samples for verification of each type of exposed finish required, prepared in components of the same thickness and metal indicated for the final Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
- H. Design Data:
 - 1. Submit calculations or test data demonstrating that the railings will resist the loads specified in the California Building Code at the post spacing provided.
 - 2. Submit manufacturer's load and deflection tables for grating, and aluminum plank grating.
 - 3. Pre-Engineered Structures:
 - a. Submit design calculations, signed and sealed by a Civil or Structural Engineer, licensed within the State of California for the pre-engineered structure (Canopy).
 - b. Submit data showing the location, magnitude, and direction of all dead, live, wind, and seismic load reactions imposed on the structure(s) by the pre-engineered structure (canopy).
- I. Test Reports:
 - 1. Certified copy of mill test reports on each steel and aluminum proposed for use showing the physical properties and chemical analysis.
- J. Certificates:
 - 1. Submit certification that the railing system is in compliance with OSHA requirements and California Building Code.
 - 2. Submit Manufacturer's certification that pre-engineered structure (Canopy) materials meet Contract Document requirements.

3. Submit coating applicator's Certificate of Compliance that the prepared hot-dipped galvanized coating surface meets or exceeds the requirements for successful painting of the surface.

1.5 QUALITY ASSURANCE

- A. The work of 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.
- C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.
- D. All welding procedures and welder qualification shall be available at the place of manufacture and in the CONTRACTOR's field office for ENGINEER's review.
- E. All welding shall be inspected by an OWNER provided inspector qualified in accordance with AWS requirements and approved by the ENGINEER.
- F. Unless otherwise directed by the ENGINEER, the CONTRACTOR shall provide the services of an independent NACE certified coating inspector. The cost of such work, except as specifically stated otherwise, shall be paid by the CONTRACTOR. All shop applied coatings shall be inspected by an inspector, qualified in accordance with NACE requirements and approved by the ENGINEER.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Items damaged during transit, inadequate storage, improper handling, or corroded, in the opinion of the ENGINEER, shall be repaired, at the CONTRACTOR's expense, to the satisfaction of the ENGINEER prior to incorporating them into the work.

1.7 PROJECT/SITE REQUIREMENTS

- A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.
- C. Steel – Unless otherwise noted:

1. Shapes, Plates, Bars: ASTM A36, unless otherwise noted.
2. Wide-flange structural steel shapes: ASTM A992.
3. Pipe, Pipe Columns, Bollards: ASTM A53, Type E or S, Grade B Standard weight unless noted otherwise.
4. Tubes: ASTM A500 Grade B.
5. Corrosion Protection - Unless otherwise indicated, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 09960 – Protective Coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

D. Stainless Steel – Unless otherwise noted:

1. Exterior - Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316 (Type 316L for welding) stainless steel and shall not be galvanized. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.
2. Interior/Architectural - Stainless steel plates, sheets, and structural shapes ASTM A167, Type 316.

E. Aluminum – Unless otherwise noted:

1. Extruded Pipe ASTM B429, Alloy 6063-T6.
2. Extruded Shapes ASTM B221, Alloy 6061-T6.
3. Sheet and Plate ASTM B209, Alloy 6061-T6.
4. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the Section 09960 – Protective Coating.

F. Cast Iron – Unless otherwise noted:

1. Iron castings shall conform to the requirements of ASTM A48, Class 50B or better.

G. Bolts, Nuts, and Washers – Unless otherwise noted:

1. Carbon Steel Bolts and Studs ASTM A307, Grade A (hot dip galvanized nuts and washers where noted).
2. Carbon Steel Anchor Bolts for building anchorage ASTM F1554 Grade 36, unless otherwise noted (hot dip galvanized nuts and washers where noted).
3. Stainless Steel Bolts, Nuts, and Washers, ASTM F593 and ASTM F594, Type 316.
4. High Strength Steel Bolts, Nuts, and Washers ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted).

a. Elevated Temperature Exposure Type I.

b. General application Type I or Type II

H. Galvanizing – Per ASTM A123.

I. Galvanizing – Per ASTM A153.

J. Duplex System – Galvanizing shall satisfy the requirements of ASTM A123 or A153, as applicable. Water quenching or chromate conversion coating shall be avoided as these processes may interfere with paint adhesion and surface preparation.

2.2 MISCELLANEOUS ALUMINUM

A. All miscellaneous metal work 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. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitively shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum-exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosing, and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.

D. Angle frames for hatches, beams, grates, etc, shall be complete with welded strap anchors attached.

E. Stair treads for aluminum stairs shall have abrasive non-slip nosing as approved.

F. Aluminum nosing at concrete stairs shall be Alumogrit Treads, Type 116, by Wooster Products, Inc.; similar by Barry Pattern and Foundry Co.; or approved equal. Furnish with wing type anchors and flat head stainless steel machine screws, 12-in on center. Nosing shall also be used at concrete ladder openings. Nosing shall be a single piece for each step extending to within 3-in at each side of stair or full ladder width. Set nosing flush with stair treads finish at concrete stairs. Furnish treads with heavy-duty protective tape cover.

2.3 MISCELLANEOUS STEEL

A. All miscellaneous metal work 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. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitively shown or specified.

- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold down straps and lugs, door frames, splice plates, sub framing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.
- D. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.
- E. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.
- F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.

2.4 MISCELLANEOUS STAINLESS STEEL

- A. All miscellaneous metal work 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. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitively shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Provide miscellaneous metal framing, supports, and other metal items required, including framing for architectural infill panels, which are not a part of the structural steel framework but are required to complete the work.

- B. Fabricate miscellaneous units to the sizes, shapes, and profiles shown or, if not shown, of the required dimensions to receive adjacent grating, plates, tanks, doors, or other work to be retained by the framing. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
- C. Equip units with integrally welded anchors for casting into concrete. Furnished inserts for units must be installed after concrete is placed.
- D. Except as otherwise shown, space anchors, 24-inches on center, and provide units equivalent of 1¼-inch by 1¼-inch by 8-inch strips.
- E. Galvanize all miscellaneous framing and supports.

2.6 FRAMING SUPPORT SYSTEMS FOR PIPE ASSEMBLIES, ANALYZERS AND APPURTENANCES

- A. Provide framing support systems for pipe assemblies shown on the Contract Drawings.
- B. Furnish and install all anchoring and connecting hardware required for assembly and installation of the framing support system(s).
- C. All anchoring and connecting hardware shall be Type 316 Stainless Steel.
- D. All exterior framing support systems, and all systems within sub grade vaults, for pipe assemblies and appurtenances shall be fabricated of Type 316 Stainless Steel.
- E. All framing support systems that are used in interior, non-submerged applications shall be fabricated of low carbon steel and furnished with a factory-applied, hot-dipped, galvanized coating.
- F. Where framing support systems are shown in locations with no adjacent wall, the framing support system shall be free-standing and designed to withstand a point load of 200-pounds applied at the top of the framing system such that the maximum deflection shall not exceed ¼-inch. Base support members shall be a minimum of 2-feet long and shall use Unistrut P2348 connectors, or approved equal.
- G. Manufacturer – Unless otherwise shown, all members shall be P1000, manufactured by Unistrut, or approved equal, with type "HS" hole pattern.

2.7 PRE-ENGINEERED STRUCTURE (CANOPY)

- A. The pre-engineered structure shall be Navajo Shelter, as manufactured by Americana Building Products, Hip Shelter, as manufactured by Icon Shelter Systems, Inc., or approved equal. Pre-Engineered Structure (Canopy)
- B. Roof Panels – Structural panels shall be roll-formed stucco embossed aluminum with a watertight snap lock connection. Panels shall be 2½-inches in depth and provided a net coverage of 24-inches. Panels shall be constructed from aluminum alloy 300-H154. The panel shall be coated with the finest thermosetting acrylic finish, color to match other site structures or as selected by the OWNER.

- C. Column and Rafters – Structural columns and rafters shall be constructed from square hollow structural sections, 6-inch minimum dimension. The steel shall conform to ASTM A500 with minimum of 46,000 psi yield strength and 58,000 psi tensile strength.
- D. Plates – Column base-plates, butt-plates, and diagonal bracing shall be constructed from steel plate conforming to ASTM A36.
- E. Gutter, Fascia, and Trim – Aluminum gutter, fascia, and trim shall be provided. Components shall be constructed from aluminum alloy 6063-T5 or 6105-T5.
- F. Fasteners – Structural steel bolts shall meet the requirements of ASTM A325 or A307. Roof panels to structural steel, at a minimum, #12x $\frac{3}{4}$ " #3 TEK zinc plated hex head and neoprene washer, or approved equal. Gutter or fascia to roof panels, at a minimum, #8-18x $\frac{3}{4}$ " #2 TEK 410SS, or approved equal. Sheet metal screws shall be either cadmium or zinc-plated.
- G. Welding – All welding shall comply with AWS D5.1 or AWS D5.5, E70XX Electrodes.
- H. Protective Coating – All steel finish work shall receive a shop applied polyamide epoxy primer over galvanized steel elements (Duplex System) in accordance with Section 09970 – Shop Painting of Hot-Dipped Galvanized Steel.

2.8 METAL GRATING

- A. General: Metal grating shall be of the design, sizes and types indicated. Grating shall be completely banded at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Support members shall support grating on all sides of an opening. Where grating is supported on concrete, embedded support angles matching grating material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.
- B. All pieces of grating shall be securely fastened in two locations to each support. Grating clips, fasteners, anchors, bolts, nuts, and washers for grating and supports shall be Type 316 Stainless Steel.
- C. Where grating forms the landing at the top of a stairway, the edge of the grating, which forms the top riser, shall have an integral non-slip nosing, width equal to that of the stairway.
- D. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. For standard duty, plank, and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100-psf, whichever is greater or a concentrated load of 1000 pounds. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HL-93 (HS20).
- E. At a minimum, grating bars shall be I-bar configuration and be spaced at 1-3/16-inches on center. Crossbars shall be spaced at 4-inches on center, unless otherwise noted.
- F. Grating cross bars shall be attached to the bearing bars with interlocked swaged joints having no exposed welding.

- G. Openings 2-inch or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.
- H. Unless otherwise designated by the ENGINEER, the maximum weight of each grating section shall be 80-pounds.
- I. Material:
 - 1. Except where indicated otherwise, bar grating shall be fabricated entirely of aluminum, Alloy 6063-T6.
 - 2. Grating which may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.
 - 3. Grating frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6061-T6 or as specified on the drawings.
- J. Standard Duty Grating:
 - 1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.
 - 2. Crossbars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.
- K. Safety Grating:
 - 1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inch by 11/16 inch in size. Safety grating shall be Grip Strut by G.S. Metals; Safe-T-Grid by IKG Industries, or approved equal.

2.9 ALUMINUM PLANK GRATING

- A. General: Aluminum Plank Grating (plank) shall be of the design, sizes and types indicated within the Drawings or specified herein. Support members shall support plank on all sides of an opening. Where plank is supported on concrete, embedded support angles matching plank material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.
- B. Unless otherwise noted, punched plank shall consist of 3"x19/32" rectangular openings, 1½-inch center-to-center and with raised transverse ribs for stiffness.
- C. Planks shall be provided with a skid resistance surface, SlipNot® (or approved equal) surface treatment applied for added slip resistance.
- D. Unpunched plank shall be provided with recessed lift handles.
- E. All pieces of plank shall be securely fastened in two locations to each support. Tread plate, fasteners, anchors, bolts, nuts and washers for supports shall be Type 316 Stainless Steel.

- F. Where plank depth is not given, tread plate shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of $\frac{1}{4}$ inch or the span divided by 180, whichever is less. For standard duty, tread plate, shall be the uniform live load of the adjacent floor or 100-psf, whichever is greater or a concentrated load of 1000 pounds.
- G. Unless otherwise designated by the ENGINEER, the maximum weight of each plank grating shall be 80-pounds.
- H. Material:
 - 1. Except where indicated otherwise, plank shall be fabricated entirely of aluminum, Alloy 6063-T6.
 - 2. Plank that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.
 - 3. Plank frames, anchors, and supports shall be all aluminum construction, fabricated from aluminum alloy 6063-T6 or as specified on the Drawings.
- I. Heavy Duty Plank Grating:
 - 1. Unless otherwise designated by the ENGINEER, no single piece of plank shall weigh more than 80 pounds. Heavy duty plank shall be fabricated by Ohio Gratings, Incorporated, Seidelhuber Metal Products, IKG, or approved equal.

2.10 CHECKERED PLATE

- A. Checkered plate shall be not less than 1/4-inch thick (3/8-inch plate thickness for aluminum), and shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of one inch in length and raised a minimum of 0.050 inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in two orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.
- B. Where no plate material is indicated on the drawings, aluminum alloy 6061-T6 shall be provided. Unless noted otherwise on the drawings, the minimum plate thickness shall be as required to limit deflection, resulting from the greater of the uniform live load of the adjacent floor or a live load of 100 psf, to 1/4-inch or the span divided by 240, whichever is less.
- C. Cover plate fastening devices and hardware shall be Type 316 Stainless Steel.
- D. Mill Finish.

2.11 FLOOR HATCHES

- A. Where access hatches are called for on the drawings to be mounted on a floor slab (including top slabs which are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated herein.
- B. All hatches shall be fabricated from Aluminum 6061-T6 unless otherwise indicated. All hatch hardware shall be Type 316 stainless steel. Hatches shall be gutter-type; Bilco Type "J" or "JD"; Babcock-Davis type "B-FGA" or approved equal, or as shown.

C. Design Live Loads:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 pounds per square foot, unless indicated otherwise.
2. Exterior covers and grates shall be designed for AASHTO HL-93 (HS20) loading unless indicated otherwise.

D. Hatch Opening:

1. Sizes, number and direction of swing of door leaves, and locations, shall be as indicated on the Drawings. Sizes given shall be for the clear opening. Where the number of leaves is not given, openings larger than 42 inches in either direction shall have double-leaf doors.
2. Unless indicated otherwise, hinges shall be located on the longer dimension side.
3. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension, and the door hinge opposite the ladder.
4. Door leaves shall be a minimum of 1/4-inch checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter.
5. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening by one person from both inside and outside and shall be balanced to require no more than 30 pounds of opening force (lift-assist). Compression spring operators enclosed in telescoping tubes shall be provided for smooth, easy and controlled door operation throughout the entire arc of opening and closing.
6. Hatches shall be designed to be watertight and shall be equipped with a joint gutter and moat-type edge drain. A 1½-inch diameter (minimum) drain connection shall be provided and located by the manufacturer.
7. Hatches shall include a recessed hasp for a padlock that is covered by a hinged lid flush with the surface.

2.12 IRON CASTINGS

- A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shot blasting.
- B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finish surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.
- C. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no loading is given, a minimum of 300 pounds per square foot, unless indicated otherwise.
2. Exterior covers and grates shall be designed for AASHTO HL-93 (HS20) loading unless indicated otherwise.

2.13 STEEL PROTECTION POSTS (BOLLARDS)

- A. Provide 4-inch diameter, Schedule 40 steel pipe, 4'-0" above grade, 3'-6" below grade.

2.14 FALL PREVENTION SYSTEM

- A. The fall prevention system shall be the RTC-2000 Climb Rite, as manufactured by Sellstrom; Saf-T-Climb, as manufactured by North Products, Inc., or approved equal. All necessary components shall be provided, including two safety belts for each fall prevention installation to provide a complete and fully operational fall prevention system. A rail extension shall be provided for each installation. At all locations where fall prevention systems are installed, a safety chain with a snap hook shall be permanently attached to the top of the ladder. The chain shall be long enough to allow a person to connect the belt to the chain while standing on the landing adjacent to the ladder. The chain and snap hook shall have a minimum allowable capacity of 500 pounds. Safety belts shall fit a waist range from 23 inches to 54 inches. Safety rails and associated accessories shall match the ladder material. Fiberglass ladders shall have stainless steel safety rails and accessories

2.15 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A307, Grade A.
- B. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
 1. All buried locations.
 2. All submerged locations.
 3. All locations subject to seasonal or occasional flooding.
 4. Inside hydraulic structures below the top of the structure.
 5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.
 6. All chemical handling areas.
 7. Inside trenches, containment walls, and curbed areas.

8. Locations indicated on the Contract Documents or designated by the ENGINEER to be provided with stainless steel bolts.
- C. All bolted connections for aluminum members shall be stainless steel.
- D. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A276. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.
 2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL; or approved equal.
- E. Bolt Requirements:
1. The bolt and nut material shall be free-cutting steel.
 2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
 3. All bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.
 4. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.
- F. Cast-in-Place Anchor Bolts – Unless otherwise indicated, the embedded end of the anchor bolt shall be either headed or with nut and washer. Threaded dimensions for cast-in headed studs and/or headed bolts, prior to zinc coating, shall conform to the requirements of ANSI/ASME B1.1 having Class 2A tolerances (ANSI/ASME Standard B1.13M Grade 6g). Use of hooked bolts (J-bolts and L-bolts) in lieu of headed studs/bolts is not permissible.
1. Equipment subject to vibration e.g., pumps, motors, generators, etc. shall be anchored by means of cast-in-place anchor bolts. Anchor bolt layout shall be by means of a template obtained from the equipment manufacturer or supplier.
- G. Adhesive Anchors - Unless otherwise indicated, all adhesive anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.4. No substitutions will be considered unless accompanied with ICC-ES report verifying strength and material equivalency and compliance with ACI 355.4.
1. Adhesive anchors shall be Hilti HIT-RE 500-SD adhesive anchors (Hilti HIT-HY 150-SD if exposed to influent), Simpson SET-XP epoxy adhesive anchors, or approved equal.

2. Adhesive anchors shall not be used for overhead installations (i.e. installations at the underside of concrete slabs).
- H. Expansion (Wedge) Anchors – Unless otherwise indicated all expansion anchors for installation in concrete shall have satisfied the requirements of the Simulated Seismic Tests of ACI 355.2. Expansion Anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel, wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-inch behind the concrete reinforcing steel.
1. Expansion anchors shall be Hilti Kwik Bolt TZ anchors, Simpson Strong-Bolt Wedge anchors, or approved equal.
 2. Shell and Lead caulking anchors will not be permitted.
 3. Post installed concrete anchors (mechanical and adhesive), shall not be used with equipment subject to vibration e.g., pumps, motors, etc.
- 2.16 POWDER DRIVEN PINS (PDA)
- A. Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they are to be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.
- 2.17 IMPACT ANCHOR
- A. Impact anchors shall be an expansion type anchor in which a nail type pin is driven to produce the expansive force. It shall have a zinc sleeve with a mushroom style head and stainless steel nail pin. Anchors shall be Metal Hit Anchors, manufactured by Hilti, Inc., Zamac Nailin, manufactured by the Powers Fasteners; or approved equal.

PART 3 EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

- A. Fabrication and Erection: Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Steel Construction Manual."
- B. All steel surfaces that come into contact with exposed concrete 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 contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

- D. Where aluminum contacts concrete/masonry, apply one coat of TT-P-645B zinc-molybdate primer or a heavy coat of approved alkali resistant bituminous paint to the aluminum or concrete/masonry.
- E. Aluminum Components:
1. Electrolysis protection of materials shall be provided.
 2. Between aluminum grating, aluminum tread plate, or aluminum-stair treads, and steel supports, insert 1/4-in thick neoprene isolator pads, 85 plus or minus 5 Shore-A-Durometer, sized for full width and length of bracket or support.
- F. Floor Hatches: Unless otherwise shown, the CONTRACTOR shall furnish and install a 1½-inch drain line to the nearest floor drain for all floor hatches.
- G. Powder-Driven Pins: Powder-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum Thickness	Pin's Shank Penetration in Supporting Material	Minimum Space from Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D Minimum	14D	20D
Steel	1/4 Inch	Steel Thickness	4D	7D

3.2 WELDING

- A. Method - All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
- B. Welding electrodes shall meet the minimum requirements of E70XX. Filler metal for welds in moment connections shall have a minimum CVN value of 20-ft-lb at 0 degrees F.
- C. Quality - In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3.3 GALVANIZING

- A. All structural steel plates shapes, bars and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A123. Galvanizing process shall be performed in strict accordance with the requirements of ASTM A384, any galvanized part(s) that become warped as a result of the galvanizing process and/or handling shall be straightened or replaced at no additional expense to the OWNER. Bolts, anchor bolts, nuts and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.
- B. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.
- C. Repair of Damaged Coating:
 - 1. Maximum area that shall be repaired shall comply with applicable sections of ASTM A123.
 - 2. Repair areas by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16" in width. Minimum thickness requirements for the repair are as described in ASTM A123.
 - 3. Field repairs to galvanizing shall be made using "Galva- Guard," "Galvite," or approved equal.
- D. Elements to be painted after galvanizing (duplex-system) shall comply with Section 09970 – Shop Painting of Hot Dipped Galvanized Steel, of the Contract Documents.

3.4 DRILLED ANCHORS

- A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
- B. Holes shall be roughened with a brush on a power drill, cleaned and dry.
- C. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength.
- D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.
- E. Mechanical anchors shall be checked for tightness a minimum of 24 hours after initial installation. Install anchors using the manufacturer's recommended drive units and adapters and in compliance with the manufacturer's recommendations.

3.5 FALL PREVENTION SYSTEM

- A. Fall prevention systems shall be provided on all ladders used to ascend heights exceeding 20 feet.

END OF SECTION

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SECTION 05510 – METAL STAIRS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals necessary and install aluminum stairs complete with anchors and brackets, including integral handrails and posts when applicable, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300, Cast-in-Place Concrete
- B. Section 05500, Miscellaneous Metals
- C. Section 05520, Aluminum Guardrails and Handrails

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM):
 - 1. ASTM B221 – Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 2. ASTM E985 – Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
- B. American Institute for Steel Construction (AISC):
 - 1. AISC S326-1978 (Supplement No.1 – 1986) – Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
- C. Aluminum Association (AA):
 - 1. Specifications for Aluminum Structures.
 - 2. AA 6061-T6 – Aluminum Sheet and Plates.
- D. American Welding Society (AWS):
 - 1. AWS D1.1 – Structural Welding Code Steel.
- E. American National Standards Institute (ANSI):
 - 1. ANSI A202.1 – Metal Bar Grating Manual for Steel and Aluminum Gratings and Stair Treads.
- F. National Association of Architectural Metal Manufacturers (NAAMM):
 - 1. NAAMM AMP 510 – Metal Stairs Manual.

- G. Occupational Safety and Health Standards (OSHA)
- H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 PERFORMANCE REQUIREMENTS

- A. General – Pre-fabricated Aluminum Stairs shall be designed to withstand structural loads indicated, determine allowable design working stresses based on Aluminum Association (AA) "Specifications for Aluminum Structures."
- B. Structural Performance of Pre-fabricated Aluminum Stairs: Engineer, fabricate, and install to comply with requirements of ASTM E985 for structural performance based on structural computations.
- C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installation to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
- D. Temperature Change (Range): Allowance for thermal movement shall be based on a temperature change of plus and minus 90 degrees F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.
- E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS

- A. Submit manufacturer's shop drawings, in accordance with Division 1, Shop Drawing Procedures, showing dimensions, material lists, methods of supporting, methods of anchoring and finishes.
- B. Product data for manufacturer's product lines of Pre-fabricated Aluminum Stairs assembled from standard components. Submit product data for grout, anchoring cement, and paint products.
- C. Shop drawings showing fabrication and installation of Pre-fabricated Aluminum Stairs including plans, elevations, sections, details of components, and attachments to other units of Work.
- D. Samples for verification of each type of exposed finish required, prepared on components of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
- E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with

project names and addresses, names and addresses of architects and owners, and other information specified.

- F. Furnish to the ENGINEER a letter signed and sealed by a Civil/Structural Engineer licensed in the State of California that the stair design conforms to the design criteria set forth by the ENGINEER.
- G. Submit to the ENGINEER data showing the location, magnitude and direction of all dead and live load reactions imposed on the structure by the stair and railing system.
- H. Furnish to the ENGINEER Manufacturer's certification that materials meet specification requirements.

1.6 QUALITY ASSURANCE

- A. Single-Source Responsibility – Obtain Pre-fabricated Aluminum Stairs from a single manufacturer.
- B. Engineer Qualifications – A professional engineer legally authorized to practice in the jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the installation of similar stairs to this Project in material, design, and extent and that have a record of successful in-service performance.
- C. All welding shall be performed by qualified welders and shall conform to AWS aluminum welding code, AWS D1.2.
- D. All welding procedures and welder qualification shall be available at the place of manufacture for ENGINEER's review.
- E. Industry Standards – Comply with the provisions of the following standards and specifications:
 - 1. AISC S326
 - 2. NAAMM – AMP-510
 - 3. AWS–D1.1

1.7 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered promptly so as to cause no delay with other parts of the work. Stored materials shall be placed on skids and not on the ground and shall be piled and blocked up so that they will not become bent or otherwise damaged. Materials shall be stored inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity. Materials shall be handled with cranes or derricks as far as practicable. Material shall not be dumped off cars or trucks nor handled in any other way likely to cause damage. Materials with excessive damage, in the opinion of the ENGINEER, shall not be incorporated in the work and shall be removed and replaced with new undamaged materials by the CONTRACTOR at no expense to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.
- C. Aluminum: ASTM B221, Alloy 6061-T6, Finish AA-C22A31.
- D. Components:
 - 1. Stringers – Aluminum
 - 2. Headers – Aluminum
 - 3. Treads – Aluminum
 - 4. Risers – Aluminum
 - 5. Platforms – Aluminum
 - 6. Railings – Aluminum

2.2 HANDRAILS–ALUMINUM

- A. Size members as required by design calculations and to conform to layout details shown. Detail stair risers, treads and landings to conform to the requirements of the current edition of OSHA.
- B. Fabricate stairs, landings and component connections to support a minimum live load of 100-psf with deflection of stairs and landings not to exceed $L/360$. Stairs exceeding vertical height of 12-ft. shall have intermediate landings.
- C. Fabricate railing supports and component connections capable of resisting a lateral force of 200-lbs at any single point, without permanent set or damage.
- D. Fabricate stair with closed risers and closed treads using structural aluminum channels, angles, plates and extrusions for stringers, treads and all supports. Provide closures for exposed ends of stringers.
- E. Fabricate treads from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit.
- F. Fabricate landings from extruded/cast structural aluminum grating with integral nosing to form a one-piece structural unit. Construct with perimeter structural aluminum channels as shown, side-supported headers and miscellaneous framing members framing into the stair stringers. Reinforce underside of landings.

- G. Construct stairs to conform to sizes and arrangements indicated; join pieces together by welding wherever possible. Weld assemblies in accordance with recommendations of AWS. Grind all exposed welds to a match and blend with adjoining surfaces.
- H. Provide complete stair assemblies including framing, columns, railings, struts, clips, brackets, bearing plates and all other components necessary for the support of stairs and landings and as required to anchor and contain the stairs on the supporting structure.
- I. Shop assemble sections in largest sizes practical, easily maneuverable through building openings.
- J. Form work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of approximately 1/32-in. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

PART 3 EXECUTION

3.1 ERECTION

- A. Erect stairs square, level, plumb and free from distortion or defects detrimental to appearance and performance.
- B. Provide necessary anchors, plates, angles, hangers and struts as required for connecting stairs to the structure.
- C. Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.
- D. Perform necessary cutting and altering for the installation of work of other Sections. Do not perform any other additional cutting without review of the ENGINEER.
- E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible. Where not hidden, use flush countersunk fastenings, unless indicated otherwise. Make mechanically fastened joints flush hairline butted. Grind welds smooth and flush.

3.2 PROTECTION

- A. Protect aluminum fabrications from damage due to work of adjacent trades.

3.3 CLEANING

- A. As work progresses, remove debris and leave installation sites broom clean.
- B. Prior to final acceptance, clean stairs of any paint, mud or other adherents.

END OF SECTION

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SECTION 05520– ALUMINUM HANDRAILS AND GUARDRAILS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment, incidentals, and services necessary to install ornamental aluminum guardrails and handrails as shown on the Drawings and as specified herein.
- B. Related Work Specified Elsewhere:
 - 1. Section 03600, Grout
 - 2. Section 05500, Miscellaneous Metals
 - 3. Section 05513, Aluminum Ladders and Accessories

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM)
 - 1. ASTM-B210 - Standard Specification for Aluminum and Aluminum Alloy Drawn Seamless Tube.
 - 2. ASTM-B221 - Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes.
 - 3. ASTM-B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - 4. ASTM-E488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 - 5. ASTM-E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
- B. Society for Protective Coatings (SSPC)
 - 1. SSPC-Paint 12 - Cold Applied Asphalt Mastic (Extra Thick Film).
- C. National Association of Architectural Metal Manufacturers (NAAMM)
 - 1. Metal Finishes Manual.
- D. Aluminum Association (AA)
 - 1. AA-M12C22A41 - M12 – Mechanical Finish, Non-Specular; C22 – Finish, Medium Matte; A41 – Clear Anodic Coating, Class I
- E. American Architectural Manufacturers Association (AAMA)

1. AAMA 607.1

- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.3 SUBMITTALS

- A. Submit, in accordance with Division 1, Shop Drawing Procedures, product data for manufacturer's product lines of guardrails and handrails assembled from standard components.
1. Shop Drawing Procedures, shop drawings showing fabrication and installation of guardrails and handrails including plans, elevations, sections, details of components, gates, and attachments to other units of Work.
 2. For installed guardrails and handrails indicated to comply with certain design loadings, include structural analysis data, sealed and signed by the qualified Professional Engineer who was responsible for their preparation.
 3. Samples – Samples for verification of each type of exposed finish required, prepared on components indicated below of same thickness and metal indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
 4. Samples – 6-inch-long sections of each distinctly different linear guardrail member, including handrails, top rails, posts, and balusters.
 5. Shop Drawing Procedures, qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Testing – Testing Laboratory Services, product test reports from a qualified independent testing agency evidencing compliance of guardrails and handrails with requirements based on comprehensive testing of current products.
- C. Certification – Testing Laboratory Services, test reports from independent testing agency evidencing compliance of guardrails and handrails with ASTM E985.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility – Obtain guardrails and handrails of each type and material from a single manufacturer.
- B. All welding shall be performed by qualified welders and shall conform AWS aluminum welding code, AWS D1.2.
- C. All welding procedures and welder qualification shall be available at the place of manufacture for ENGINEER's review.
- D. Engineer Qualifications - A Professional Civil or Structural Engineer licensed in the State of California and experienced in providing engineering services of the kind

indicated that have resulted in the installation of guardrails and handrails similar to this Project in material, design, and extent and that have a record of successful in-service performance.

1.5 PERFORMANCE REQUIREMENTS

- A. General – In engineering guardrail and handrails to withstand structural loads indicated, determine allowable design working stresses of guardrail materials based on Aluminum Association (AA) "Specifications for Aluminum Structures".
- B. Structural Performance of Guardrails and Handrails – Engineer, fabricate, and install guardrails and handrails to comply with requirements of ASTM E985 for structural performance based on structural computations.
- C. Thermal Movements – Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installing guardrails and handrails to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
- D. Temperature Change (Range): Allowance for thermal movement shall be based on temperature change of plus or minus 90 degrees-F from the average ambient temperature at the project site, or from the temperature at time of installation, whichever is more stringent.
- E. Control of Corrosion – Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Store guardrails and handrails inside a well-ventilated area, away from uncured concrete and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

- A. Field Measurements – Where guardrails and handrails are indicated to fit to other construction, CONTRACTOR shall check actual dimensions of other construction by accurate field measurements before fabrication. CONTRACTOR shall provide field measurements to manufacturer/supplier such that they may be shown on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

- B. All like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.2 MANUFACTURERS

- A. 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:
 - 1. Julius Blum & Co., Inc.
 - 2. Blumcraft of Pittsburgh.
 - 3. J.G. Braun Co.
 - 4. Newman Brothers, Inc.
 - 5. Approved equal

2.3 METALS

- A. General – Provide metal free from surface blemishes where exposed to view in the finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.
- B. Aluminum – Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of the alloy and temper designated below for each aluminum form required.
 - 1. Extruded Bar and Tube: ASTM B221, alloy 6063-T5/T52.
 - 2. Extruded Structural Pipe and Tube: ASTM B429, 6063-T6.
 - 3. Drawn Seamless Tube: ASTM B210, 6063-T832.
 - 4. Plate and Sheet: ASTM B209, 6061-T6.
 - 5. Die and Hand Forgings: ASTM B247, 6061-T6.
 - 6. Castings: ASTM B26, A356-T6.

2.4 FASTENERS

- A. Fasteners for Anchoring Guardrails to Other Construction – Select fasteners of the type, grade, and class required to produce connections that are suitable for anchoring guardrail to other types of construction indicated and capable of withstanding design loadings.
 - 1. For aluminum guardrails, provide fasteners fabricated from Type 304 or Type 316 Stainless Steel.

- B. Fasteners for Interconnecting Guardrail Components – Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Provide concealed fasteners for interconnecting guardrail and handrail components and for attaching them to other work, except where exposed fasteners are unavoidable or are the standard fastening method for guardrail and handrail system indicated.
 - 2. Provide Phillips flathead machine screws for exposed fasteners, unless otherwise indicated.
 - C. Cast-in-Place and Post installed Anchors – Anchors of type indicated below, fabricated from corrosion-resistant materials. Except where more stringent requirements are indicated below, provide anchors with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete, as determined by testing per ASTM E488 conducted by a qualified independent testing agency.
 - 1. Cast-In-Place Anchors – Comply with CBC Section 1911 or 1912 for cast-in-place anchor values.
 - 2. Expansion Anchors – Comply with requirements of Section 05500.
 - 3. Adhesive Anchors – Comply with requirements of Section 05500.
- 2.5 PAINT
- A. Bituminous Paint – Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.
- 2.6 GROUT AND ANCHORING CEMENT
- A. Comply with requirements of Section 03600.
- 2.7 FABRICATION
- A. General – Fabricate guardrails and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacing, and anchorage, but not less than that required to support structural loads.
 - B. Assemble guardrail systems in shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
 - C. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of guardrail and handrail components.

- D. Non-welded Connections – Fabricate guardrails and handrails by connecting members with guardrail manufacturer's standard concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- E. Brackets, Flanges, Fittings, and Anchors: Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect guardrail and handrail members to other construction.
- F. Provide inserts and other anchorage devices to connect guardrails and handrails to concrete work. Fabricate anchorage devices capable of withstanding loads imposed by guardrails and handrails. Coordinate anchorage devices with supporting structure.
- G. For removable railing posts, fabricate slip-fit sockets from aluminum pipe whose inside diameter is sized for a close fit with posts and to limit deflection of post without lateral load, measured at top, to not more than 1/12 of post height. Provide socket covers designed and fabricated to resist accidental dislodgement.
- H. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
- I. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing work.
- J. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.
- K. Provide weep holes or other means to drain entrapped water in hollow sections of guardrail members that are exposed to exterior or to moisture from condensation or other sources.
- L. Fabricate joints that will be exposed to weather in a watertight manner.
- M. Close exposed ends of guardrail and handrail members with prefabricated end fittings.
- N. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of the handrail and wall is ¼-inch or less.
- O. Toe Boards – Where indicated, provide toe boards at guardrails around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
- P. Fillers – Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thickness. Size fillers to produce adequate bearing to prevent bracket rotation and overstressing of substrate.

- Q. Gates – Provide swing-type gates where indicated. Unless otherwise shown, fabricate gates with components to match adjacent guardrails. Furnish gates with aluminum or stainless steel hinges and keeper/latch mechanism.

2.8 FINISH

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.
- B. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
- C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.7 mil or thicker) complying with AAMA 607.1.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors, that are to be embedded in concrete construction. Coordinate delivery of such items to Project site.

3.2 INSTALLATION - GENERAL

- A. Fit exposed connections accurately together to form tight, hairline joints.
- B. Cutting, Fitting, and Placement – Perform cutting, drilling, and fitting required for installing guardrails and handrails. Set guardrails and handrails accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of guardrail and handrail components that have been coated or finished after fabrication and are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb.
 - 3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4-inch in 12 feet.
- C. Corrosion Protection – Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust guardrails and handrails prior to anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated but not more than that required by structural loads.

- E. Fastening to In-Place Construction – Use anchorage devices and fasteners where necessary for securing guardrails and handrails and for properly transferring loads to in-place construction.

3.3 GUARDRAIL CONNECTIONS

- A. Non-welded Connections – Use mechanical joints for permanently connecting guardrail components. Seal recessed holes of exposed locking screws using plastic filler, cement colored to match finish of guardrails and handrails.
- B. Expansion Joints: Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2-inches beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6-inches of post.

3.4 ANCHORING POSTS

- A. Anchor posts in concrete by forming or core-drilling holes not less than 6-inches deep and $\frac{3}{4}$ -inch greater than outside diameter of post. Clean holes of all loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's directions.
- B. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8-inch buildup, sloped away from post.
- C. Anchor posts to metal surfaces with oval flanges, angle type or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum guardrails, attach posts as indicated using fittings designed and engineered for this purpose.
- D. Install removable guardrail sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.

3.5 ANCHORING RAIL ENDS

- A. Anchor rail ends into concrete with round flanges connected to rail ends and anchored into wall construction with post installed anchors and bolts.
- B. Anchor rail ends to metal surfaces with oval or round flanges.
 - 1. Connect flanges to rail ends using non-welded connections.

3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets and end fittings. Provide bracket with $1\frac{1}{2}$ -inches clearance from inside face of handrail and finished wall surface.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets and wall return fittings to building construction as follows.

1. Use type of bracket with predrilled hole for exposed bolt anchorage.
2. For concrete anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.
3. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 ADJUSTING AND CLEANING

- A. Clean soiled surfaces by washing thoroughly with clean water and soap, followed by rinsing with clean water.

3.8 PROTECTION

- A. Protect finishes of guardrails and handrails from damage during construction period with temporary protective coverings approved by guardrail manufacturer. Remove protective coverings at the time of Final Completion.
- B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units at no additional cost to the OWNER.

END OF SECTION

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SECTION 05530 - LANDSCAPE METALWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all labor, materials and equipment as required for complete, finished installation of metalwork as shown on the drawings and specified including the following items:
 - 1. Guardrails
 - 2. Miscellaneous landscape metal
- B. Metal fabrication includes plates, bars, strips, tubes, pipes and castings made from iron and steel that are not specifically listed herein.

1.2 REFERENCES AND STANDARDS

- A. "Code for Arc and Gas Welding in Building Construction" of American Welding Society, AWS D1.1, latest edition, with current supplements and addenda, is hereby made a part of this Section and miscellaneous metalwork shall conform to the applicable requirements therein, except as otherwise specified herein or shown on the drawings. Nothing contained herein shall be construed as permitting work that is contrary to code requirements or governing rules and regulations.
- B. All work shall conform to the American Institute of Steel Construction Specifications for design, erection and fabrication, and acceptable standards of good practice. Finished members shall be true to line and free from twists and bends.
- C. SSPC "Steel Structures Painting Manual, Volume 2, Systems and Specifications".
- D. National Association of Architectural Metal Manufacturers (NAAMM): Metal Finishes Manual

1.3 SUBMITTALS, per Section 01300.

- A. Product Data: Furnish manufacturer's literature including paint, grout and recommendations for cleaning.
- B. Shop Drawings: Shall show dimensions, sizes, thicknesses, gauges, finishes, joining attachments and relationship of work to adjoining construction. Where items must fit and coordinate with finished surfaces and/or constructed spaces, take measurements at site and not from drawings. Where concrete, masonry or other materials must be set to exact locations to receive work, furnish assistance and directions necessary to permit other trades to properly locate their work. Where welded connectors, concrete or masonry inserts are required to receive work, shop drawings shall show exact locations required, and all such drawings shall be furnished to the trades responsible for installing the connectors or inserts. Catalogue work sheets showing illustrated cuts of item to be furnished, scale details and dimensions may be submitted for standard manufactured items.

1. Provide templates for anchorage installations by others.
- C. Samples: Furnish finish samples of uncoated steel anchor and bolts for farm machinery, etc.
- D. Certificates: Submit certification signed by California registered civil or structural engineer indicating compliance with Contract Documents and code requirements where required.

1.4 SYSTEM DESCRIPTION

- A. Design Requirements: Drawings indicate metal sizes and shapes; unless otherwise specifically indicated, design components and fabrications of gages and thicknesses to withstand anticipated loads as required by California Building Code.
 1. Railings: Support a lateral force of 50 lbs./lin. Ft. uniform load and 200 lbs. at any single point without permanent set or damage; ASTM E 935.
 - a. Top Rails: Design to support minimum 200 lb. concentrated single point load applied at any point vertically or horizontally.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm with minimum five years successful experience fabricating metal items similar to those required for Project.

PART 2 - MATERIALS

2.1 BASIC MATERIALS AND ACCESSORIES

- A. Austenitic Stainless Steel Tubing: ASTM A269, Minimum Grade B, seamless where exposed.
- B. Austenitic Stainless Steel Pipe: ASTM A312, Grade A, seamless, minimum standard weight, STD or Schedule 40, unless otherwise noted.
- C. Miscellaneous stainless steel plates and structural steel shapes conforming to ASTM A240
- D. Bolts: Structural grade steel, ASTM F593-(latest edition), with suitable hex nuts and washers, all stainless steel.
- E. Fasteners and Rough Hardware: Type as required for specific usage; provide stainless steel fasteners for exterior use or where built into exterior walls.
- F. Welding Materials: AWS D1.1, type required for materials being welded.
- G. Stainless Steel
 1. All stainless steel shall be marine grade.
 2. Plate, Sheet and Strip: ASTM A240, Type 316. Provide mill finish unless otherwise shown.

3. Bars and Shapes: ASTM A276, Type 316. Provide mill finish unless otherwise shown.
 4. Tubing: ASTM A269
 5. Stainless Steel Railing Finishes: Submit finish sample for approval. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated free of cross scratches. Run grain with long dimension of each piece.
 6. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- H. Screws: Stainless Steel Marine Grade.
- I. Welding Electrodes: As permitted by AWS A5.
- J. Fasteners and Anchorage Devices: Provide fasteners complying with the requirements of Industrial Fasteners Institute standards. Type, grade, class and style best suited for the respective purpose. Use countersunk flat-head Phillips type machine screws for exposed fasteners, except where Allen head screws are required. Use stainless steel fasteners for exterior construction and for fastening components fabricated of stainless steel except where specified otherwise. Fasteners exposed in finish surfaces to match finish of adjacent surfaces.
- K. Component Connections: Fabricate component connections to support specified design loads.
- L. Material Selection: Select materials for straightness, free of defects and irregularities.
1. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, "oil canning", stains, discolorations, and imperfections on finished units are not acceptable.
- M. Joints: Make exposed joints flush butt type, hairline joints where mechanically fastened; provide concealed connection devices with hidden fasteners.
1. Fabricate continuous items with joints neatly fitted and secured.
 2. Ease exposed edges to approximate 1/32" uniform radius.
 3. Fabricate joints exposed to weather in manner to exclude water or provide weep holes where water could accumulate.
- N. Welding: Comply with AWS for recommended practices in welding each type of material; provide welds behind finished surfaces without distortion or discoloration on exposed side; dress exposed and contact surfaces.
- O. Exposed Mechanical Fastenings: Flush countersunk fasteners unobtrusively located, consistent with design of structure.
- P. Assemblage: Fit and shop assemble in largest practical sections for site delivery.
- Q. Dissimilar Materials: Separate dissimilar materials with bituminous paint where concealed, with preformed separators, or similar method to prevent corrosion.
- R. Cable Wire: Stainless Steel wire rope cable rails. 3/16" dia.

PART 3 - EXECUTION

- 3.1 **CONDITION OF SURFACES:** Inspect all surfaces to receive site metal work and report all defects which would interfere with this installation. Starting work implies acceptance of surfaces as satisfactory.
- 3.2 **FIELD MEASUREMENTS:** Take field measurements prior to preparation of shop drawings and fabrication, where possible; do not delay job progress; allow for trimming and fitting where necessary.
- 3.3 **WORKMANSHIP**
- A. Verify all measurements at job. Coordinate all metalwork with adjoining work for details of attachments, fittings, etc. Do all cutting, shearing, drilling, punching, threading, tapping, etc., required for site metalwork or for attachment of adjacent work. Drill or punch holes; do not use cutting torch. Shearing and punching shall leave true lines and surfaces. Obtain Owner's Representative's review prior to site cutting or making adjustments which are not part of scheduled work. Perform necessary cutting and altering for installation and coordination with other work.
 - B. Conceal all fastenings where feasible. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Form joints exposed to weather to exclude water.
 - C. Make all permanent connections in ferrous metal surfaces using welds where at all possible; do not use bolts or screws where they can be avoided.
 - D. Provide all lugs, clips, anchors, miscellaneous fastenings necessary for complete assembly and installation.
 - E. Set all work plumb, true, rigid, neatly trimmed out, accurately fitted and free from distortions or defects detrimental to appearance or performance. Miter corners and angles of exposed moldings and frames unless otherwise noted.
 - F. Where items must be incorporated or built into adjacent work, deliver to trade responsible for such work in sufficient time that progress of work is not delayed. Be responsible for proper location of such items.
 - G. Make provisions for erection stresses by temporary bracing; Keep work in alignment.
 - H. Install items plumb, true and in correct relation to adjacent work, free from distortion or defects detrimental to appearance and performance.
 - I. Prior to securing continuous items, adjust to ensure proper matching at butt joints and correct alignment throughout their length.
 - J. Tolerances: Accurately align and locate components to required lines and levels to conform to following tolerances:
 - 1. Plumb: 1/8" in 10'-0"; 1/4" in 40'-0"; non-cumulative.
 - 2. Level: 1/8" in 20'-0"; 1/4" in 40'-0"; non-cumulative.

3. Location: 3/8" maximum deviation from measured theoretical location (any member and location).

3.4 WELDING

- A. Perform all welding in accordance with AWS Code D1.1. Welds shall be made only by operators experienced in performing the type of work indicated. Welds normally exposed to view in the finished work shall be uniformly made and shall be ground smooth. Where welding is done in proximity to glass or finished surfaces, such surfaces shall be protected from damage due to weld sparks, spatter, or tramp metal.
- B. Field Welding: Comply with AWS Welding Code for procedures related to field welding as related to appearance and quality of welds made and for methods used in correcting welding work. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

3.5 BOLTED, SCREWED AND RIVETED CONNECTIONS

- A. In general, use bolts for field connections only and then only as detailed. Provide washers under all heads and nuts bearing on wood. Draw all nuts tight and nick threads of permanent connections to prevent loosening. Use beveled washers where bearing is on sloped surfaces.
- B. Where screws must be used for permanent connections in ferrous metal, use flat-head-type, countersunk, with screw slots filled and finished smooth and flush.
- C. Where rivets are used, they shall be machine-driven, tight, heads centered, countersunk, and finished flush and smooth.

3.6 SURFACE TREATMENT AND PROTECTIVE COATINGS

- A. Cleaning: Thoroughly clean all mill scale, rust, dirt, grease and other foreign matter from ferrous metal prior to any galvanizing, hot phosphate treatment or painting. Conditions which are too severe to be removed by hand cleaning methods shall be cleaned per SSPC "Surface Preparation Specifications," "Solvent Cleaning, SSPC-SP-1"; "Power Tool Cleaning, SSPC-SP-3"; or "Brush-Off Blast Cleaning, SSPC-SP 7"; as required.
- B. Exterior Ferrous Metal: Welds, burrs, and rough surfaces ground smooth and completed assembly cleaned, hot phosphate treated. Hot phosphate treatment not required on items which are not exposed in the finish work or on those items where size prohibits such treatment. Indicate on shop drawings where treatment is proposed to be omitted.

3.7 PAINTING

- A. Prime Coat: After material has been properly cleaned and treated, apply two shop prime coats, each of a different color, to all surfaces except those encased in concrete or masonry. Apply all paint per manufacturer's directions. Spot paint all abrasions and field connections after assembly. Shop coats shall be dry prior to shipment to job site.
- B. Finish Coats: Apply one coat per manufacturer's instructions. May be shop-applied where applicable.

3.8 GALVANIZING

- A. Galvanize fabricated items after fabrication in accordance with ASTM A123-66.
- B. Parts shall be made in suitable sections. First clean in a hot pickling bath to remove all scale and then rinse clean with clear water. After pickling and washing, dip parts in liquid zinc tank sufficient length of time to heat parts to zinc temperature, then remove and allow to drip and cool; straighten as required.

3.9 INSTALLATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and other miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to the project site. Deliver items which are to be built into the work of other Sections in time so as not to delay the progress of the Work.
- B. Protect finished surfaces against damage during construction and remove protection at time of substantial completion.
- C. Railings and Guardrails:
 - 1. Anchor posts to steel members with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to steel supporting members.
- D. Immediately after erection, clean field welds, bolted connections, marred and abraded surfaces. Paint and touch-up paint with the specified paint system. Touch up galvanized surfaces in accordance with ASTM A780.
- E. Replace items damaged in course of construction.

3.10 PROTECTION AND CLEANING, per Section 01700

- A. Remove all soil and foreign matter from finished surface and apply such protective measures as may be required to prevent damage or discoloration of any kind until acceptance of project.

END OF SECTION

SECTION 06620
PVC LINERS REPAIRS

PART 1 GENERAL

A. THE REQUIREMENT

1. The CONTRACTOR shall furnish and install vinyl plastic liner in structures as shown on the Contract Drawings and herein specified. The liner shall effectively protect the concrete underneath from corrosion. The liner shall be continuous and free from any holes, weld strips tightly sealed, pipe penetrations installed properly, and all joint welding and sealing shall be as impervious as the liner. All vinyl plastic liner shall be white.
2. The final quantity of area to be paid, based on the unit price listed in the Schedule of Prices, shall be based on the areas determined by the DISTRICT COATINGS INSPECTOR. This Work shall include all flow isolation, precleaning, surface preparation, cleanup, and appurtenant work, in accordance with the requirements of the Contract Documents.
3. Interior areas of the structure shall be sealed and protected with the specified lining as shown on the Plans. All joints between individual sheets or sections of liner shall be continuously heat welded using welding strips of the same material as the liner but without the integral extension ribs.
4. Unless otherwise noted, all material, methods and testing required for the installation of liners in structures, and the field sealing and welding of joints shall be done in strict conformity with applicable published sections of the Standard Specifications for Public Works Construction, latest edition.

B. REFERENCE SPECIFICATIONS, CODES AND STANDARDS

1. Comply with the current provisions of the following Codes and Standards.
 - a. Commercial Standards:
 - b. ASTM D 638 Test Method for Tensile Properties of Plastics.
 - c. ASTM D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - d. ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension

C. CONTRACTOR SUBMITTALS

1. Submittals shall be made in accordance with the Section 01300 Submittals.
2. The following submittals and specific information shall be provided.

- a. Shop Drawings: The CONTRACTOR shall furnish shop drawings of all fabricated items and accessories with the following:
 - 1) Typical interior and exterior corners at walls and slabs.
 - 2) Terminations at top slab openings.
 - 3) Pipe penetrations.
 - 4) Terminations at embedded metal work such as hatch frames, cover plate embeds, gate guides and frames, anchors, and similar items.
 - 5) Expansion and construction joints.
 - 6) Connection to existing liners.
- b. The CONTRACTOR shall submit to the DISTRICT COATINGS INSPECTOR shop drawings of installation details at corners, roof beams, pipe penetrations, anchor bolt installations, and lower wall termination points. These drawings shall show how returns, corners and joints will be located and constructed. No liner shall be placed until these drawings have been approved by the DISTRICT COATINGS INSPECTOR.
- c. Liner installation and testing requirements.
- d. Certified test results on physical property, chemical resistance, and quality control test data.
- e. Manufacturer's installation instructions with specific details modified and tailored to each structure and portion of structure to receive liner, including attachments to formwork where applicable.
- f. Letter from lining system manufacturer endorsing the installer/fabricator as certified and factory authorized to install the lining system scheduled for this project.
- g. Statements of Qualification:
 - 1) Lining System Manufacturer: Successful use of sheet material similar to this project for a minimum period of 10 years.
 - 2) Lining System Installer: Successfully completed a minimum of five projects of similar or larger size in the last 3 years.

D. MOCK-UP

- 1. Prior to the lining application on all of the surfaces, CONTRACTOR shall construct a Mock-up of each lining installation listed under 1.03A for approval by the DISTRICT COATINGS INSPECTOR. A typical joint installation shall also be demonstrated for approval by the DISTRICT COATINGS INSPECTOR. If approved by the DISTRICT COATINGS INSPECTOR, each Mock-Up can become part of the permanent installation. If a Mock-Up is rejected by the DISTRICT COATINGS INSPECTOR, CONTRACTOR shall construct another Mock-Up at no additional cost.

1.2 PRODUCTS

A. Composition

- 1. The materials used in all sheets of plastic liner and in all joint, corner and welding strips for the liner shall be a high molecular weight polyvinyl chloride (PVC) resin and other necessary ingredients compounded to make permanently flexible sheets and strips. PVC resin shall constitute not less than 99 percent, by weight, of the resin used in the formulation. Copolymer resins shall not be permitted.

2. The material used in joint strips and in plain sheets of plastic liner shall be identical to that used in sheets having locking extensions.
3. Changes in formulation shall be permitted only after prior notification of the DISTRICT COATINGS INSPECTOR and satisfactory demonstration to the DISTRICT COATINGS INSPECTOR that the modified plastic liner meets or exceeds all requirements in this Specification.
4. Plastic liner shall be impermeable to sewage gases and liquids and shall be nonconductive to bacterial or fungal growth. All lines shall be factory checked electrically to ensure freedom from any porosity.
5. The lining shall have good impact resistance, shall be flexible, and shall have an elongation sufficient to bridge a 1/8-inch wide settling crack, which may occur in the pipe structure or joint after installation, without loss of the lining integrity.
6. Once cast into the concrete of structures or pipe, the lining shall be permanently and physically attached to the concrete by T-shaped integral locking extensions and shall not rely on an adhesive bond except where specifically indicated. The lining shall withstand a 15 psi back hydrostatic pressure applied to the under surface of the lining without losing anchorage and without rupture or leakage.
7. Approved products include Ameron T-Lock as manufactured by Ameron Protective Lining Products, Brea, California for immersed and non-immersed service. Ameron plain sheet as manufactured by Ameron Protective Lining Products, Brea, California may be used if approved by the Owner and District's Representative for some non-immersed service only.

B. Physical Properties

1. At any time prior to final acceptance of the work, including during manufacture, the DISTRICT COATINGS INSPECTOR may sample any sheet or strip. Samples shall be subject to the following tests:
 - a. Tensile specimens shall be prepared in accordance with ASTM D 412, Test Method B. These shall be cut from sheets, joint strips and flat welding strips.
 - b. Weight change specimens shall be 1- by 3-inches and of specified sheet thickness.
 - c. Test specimens shall be conditioned to a constant weight at 110 F before and after submersion in the following solutions for a period of 112 days at 77°F $\pm$ 5°. At 28-day intervals, tensile specimens and weight change specimens shall be removed from each of the chemical solutions and tested.

CHEMICAL SOLUTION	CONCENTRATION
Sulfuric Acid	20%
Sodium Hydroxide	5%
Ammonium Hydroxide	5%

Sodium Hypochlorite	1%
Nitric Acid	1%
Ferric Chloride	1%
Soap	0.1%
Detergent (Linear Alkyl Benzyl Sulfonate or Gas)	0.1%
Bacteriological mg/l	BOD not less than 700

*Volumetric percentages of concentrated C.P. grade reagents.

- d. All plastic liner sheets, joint, corner and welding strips shall have the following physical properties when tested at 77° F $\pm 5^\circ$:

Property	Initial	After 112 days exposure in above listed chemical solutions**
Tensile Strength	2200 psi min.	2100 psi min.
Elongation at break	200% min.	200% min.
Indentation hardness (Shore durometer, Type D)	Inst. 50-60	+5 with respect to initial test result
Weight change		+1.5%

**If any specimen fails to meet the 112-day requirements before completion of the 112-day exposure, the material shall be subject to rejection.

- e. Liner locking extension embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch, applied perpendicularly to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at 75°F $\pm 5^\circ$.
- f. All plastic liner sheets, including locking extensions, all joint, corner and welding strips shall be free of cracks, cleavages, or defects adversely affecting the protective characteristics of the material. The DISTRICT COATINGS INSPECTOR may authorize the repair of such defects by approved methods.
- g. Specimens shall meet the requirements listed under "PHYSICAL PROPERTIES", set forth above.

2. Thickness of Material

- a. Liner to be bonded to concrete by means of integral locking extensions embedded in the concrete shall have a minimum thickness of 0.065 inches. Liner to be bonded to concrete or steel surfaces by means of adhesive

shall have a minimum thickness of 0.094 inches. Welding strips shall have a minimum thickness of 0.094-inch and a maximum thickness of 0.156 inches. Joint strips shall have a minimum thickness of 0.075 inches.

3. Sheet and Strip Size

- a. Sheets of liner shall be as large as practicable to adequately fit the intended use.
- b. Large sheets shall be formed in the shop by lapping basic size sheets a minimum of 0.50inches and fusing the sheets together in such a manner as to produce a continuous welded joint. Specimens taken from shop welded joints shall show no cracks or separation and shall be tested in tension after flexing. Each specimen shall withstand a minimum load of 132 pounds per linear inch of weld, or the product of 2000 psi times the minimum thickness in inches of the material adjoining the weld, whichever is greater. The thickness shall be taken within a 2-inch gage length.
- c. Tears, cracks, wrinkles or separation in the laps shall be cause for rejection.
- d. Joint strips shall be 4 $\pm$ 0.25-inches wide and shall have each edge beveled prior to application.
- e. Welding strips shall be 1 $\pm$ 0.15-inch wide. All welding and outside corner strips shall have edges beveled at time of manufacture.

4. Locking Extensions

- a. All liner cast into concrete shall have integral locking extensions embedded in the concrete. Plain sheet liner may not be bonded to concrete surfaces with an unless approved by DISTRICT. Locking extensions shall be of the same material as the liner plate and shall be integral with the sheets for liner plate. Locking extensions shall have an approved cross section with a minimum height of 0.375-inch and a minimum web thickness of 0.085 inch. They shall be approximately 2-1/2 inches apart and shall be made so that when the extensions are embedded in concrete, the liner will be held permanently in place.
- b. Locking extensions shall be parallel and shall be continuous except where omitted for joints and transverse weep channels.

5. Weep Channels

- a. At 8-foot maximum intervals along liner longitudinally, a gap not less than 2 inches (3-1/2 inches in the case of extruded sheets) nor more than 4 inches wide shall be left in all locking extensions for liners of cast-in-place structures to provide an unobstructed transverse weep channel. Any area behind liner that is not properly served by regular weep channels shall have additional weep channels 2-inches wide provided by cutting away locking extensions. Provisions shall be made to permit water behind the liner of concrete to drain into the weep channels of the lined structure. Weep channels shall be cut into the extruded sheet so that a maximum of 1/32 of an inch of the base locking extension is left on the sheet.
- b. At transverse joints in cast-in-place structures, a gap of not less than 2 inches or greater than 4 inches shall be left in all locking extensions to

provide a transverse weep channel. If locking extensions are removed to provide a weep channel at joints, the base of the extension left on a sheet shall not exceed 1/32 of an inch.

- c. A transverse weep channel shall be provided approximately 12 inches from each liner return where surfaces lined with plastic liner join surfaces that are not so lined.
- d. As part of the work of installing the liner, all outlets of transverse weep channels shall be cleared of obstructions that would interfere with their proper function.

6. Flaps

- a. When transverse liner flaps are required, they shall be fabricated so that a maximum of 1/32 of an inch in height of the locking extension is left on the sheet.

C. ADHESIVES AND CLEANERS

- 1. Adhesives, solvents and activators proposed for use for application to plain sheet shall be submitted to the DISTRICT COATINGS INSPECTOR for approval. Adhesives used on the liner shall be limited to those products approved by the DISTRICT COATINGS INSPECTOR. No adhesive shall be applied to liner or to any of the liner strips, which will deleteriously affect the liner, or strip in any way. The use of most adhesives and solvents is subject to record-keeping rules of the BAAQMD Rule 8-3 as described in Section 09960 Protective Coating.
- 2. Adhesive products and flammable solvents shall not be used for any purpose in connection with plastic liner with locking extensions.
- 3. Cleaning agents for use with plastic liner with locking extensions shall be water soluble or dispersible, nonflammable, and not detrimental to the plastic liner. Approved products include Formula 409, or equal. Only approved cleaning agents shall be allowed to be used onsite.

1.3 EXECUTION

A. General

- 1. The installation of all plastic liner shall be done in accordance with the Contract Documents.
- 2. Liner shall be applied and secured to the forms and inspected and approved by the DISTRICT COATINGS INSPECTOR prior to the placement of reinforcing steel.
- 3. Special terminations shall be required at sluice and slide gate frames, manholes, pipe penetrations, anchor bolt studs, and other locations where metal work interfaces with the PVC liner. The CONTRACTOR shall submit drawings showing details of how terminations not shown on the Contract Documents are to be made. Methods of making terminations shall be subject to the DISTRICT COATINGS INSPECTOR'S approval. Approved bonding agents may be used to

seal edges where PVC liner joins metal items cast in concrete. All surfaces to be bonded shall be cleaned. Mixing and application of approved bonding agents shall be in accordance with the manufacturer's instructions.

B. Qualification of Installers

1. Applicators: The application of plastic liner to forms and other surfaces shall be considered as highly specialized work. Personnel performing this type of work shall be trained in methods of installation and shall provide manufacturer certification documentation to the DISTRICT COATINGS INSPECTOR.
2. Welders: Each welder shall prequalify by successfully passing a welding test before doing any welding. Requalification may be required at any time deemed necessary by the DISTRICT COATINGS INSPECTOR. All test welds shall be made in the presence of the CITY'S representative and shall consist of the following:
 - a. Two pieces of liner, at least 15 inches long and 9 inches wide, shall be lapped 1-1/2 inches and held in a vertical position.
 - b. A welding strip shall be positioned over the edge of the lap and welded to both pieces of liner. Each end of the welding strip shall extend at least 2 inches beyond the liner to provide tabs.
 - c. The weld specimen shall be submitted to the DISTRICT COATINGS INSPECTOR and shall be tested as follows:
 - 1) Each welding strip tab, tested separately, shall be subjected to a 10-pound pull normal to the face of the liner with the liner being held firmly in place. There shall be no separation between the welding strip and liner when the welding tabs are submitted to the test pulls.
 - 2) Three test specimens shall be cut from the welded sample and tested in tension across the welds. If none of the specimens fail when tested as specified herein, the weld will be considered as satisfactory in tension.
 - 3) If one of the specimens fails to pass the tension test, a retest will be permitted. The retest shall consist of testing three additional specimens cut from the original welded sample. If all three of the retest specimens pass the test, the weld shall be considered satisfactory.
 - 4) A disqualified welder may submit a new welding sample when, in the opinion of the DISTRICT COATINGS INSPECTOR, there has been sufficient off-the-job training or experience to warrant reexamination.

C. Placing pvc Liner

1. Coverage
 - a. Plain sheet liner shall not be allowed on flat floor immersed surfaces such as pipe channels or wet wells. The PVC liner shall terminate at the bottom of the wall per 51S-5091 Detail 1, with a batten strip or shall be tucked under the vertical wall as shown in Drawing 51S-5092 Detail 2.
 - b. At a station where there is a difference in coverage, as shown on the Plans, and the longitudinal terminal edges of liner downstream from said

station are lower than those upstream, the terminal edges of the liner installed in the section of pipe or structure immediately upstream from the station shall be sloped uniformly for the entire length of the section of pipe or structure from the limits of the smaller coverage to those of the greater coverage. Wherever the longitudinal terminal edges of liner downstream from the station are higher than those upstream, the slope shall be accomplished uniformly throughout the length of the section of pipe or structure immediately downstream from the station. An approved locking extension shall be provided along all tapered lower terminal edges of liner.

2. Positioning Liner

- a. All liner sheets installed in a cast-in-place structure shall be positioned so that the locking extensions are vertical in walls and parallel to the axis of the structure in slabs. All liner sheets installed in precast structures, such as manhole barrels and cones, shall be positioned with locking extensions horizontal unless otherwise indicated on the Plans.
- b. All liner installed in a cast-in-place structure shall be positioned so that the locking extensions are vertical in walls and parallel to the axis of the structure in slabs. All liner installed in precast structures shall be positioned with locking extensions horizontal unless otherwise indicated on the Plans.
- c. Liner sheets shall be closely fitted to inner forms. Sheets shall be cut to fit curved and warped surfaces using a minimum number of separate pieces.
- d. The CONTRACTOR shall furnish sketches to the DISTRICT COATINGS INSPECTOR showing the proposed layout of the liner sheets for cast-in-place structures. The sketches shall show the location and type of all field welds.
- e. The DISTRICT COATINGS INSPECTOR may require the use of patterns or the marking of sheet layouts directly on the forms where complicated or warped surfaces are involved.
- f. At transverse joints between regular size sheets of liner used in cast-in-place structures and at all pipe joints, the space between ends of locking extensions, measured longitudinally, shall not exceed 4 inches. Where sheets are cut and joined for the purpose of fitting irregular surfaces, this space shall not exceed 2 inches.

3. Securing Liner in Place

- a. Unless alternative methods are approved by the DISTRICT COATINGS INSPECTOR, liner shall be secured in place to the inner pipe forms with steel banding straps and the sheet shall be provided with strap channels. Only finish nails may be used on wood forms.
- b. Where form ties or form stabilizing rods pass through liner, provisions shall be made to maintain the liner in close contact with the forms during concrete placement.

4. Liner Returns

- a. A liner return shall be installed where shown on the Plans and wherever surfaces lined with plastic liner join surfaces that are not so lined, such as cast-iron pipe, manhole frames, and metal gate guides.
- b. Unless otherwise indicated, returns shall be made as follows:
 - 1) Each liner return shall be a separate strip of liner at least 3 inches wide joined to the main liner by means of approved corner strips.
 - 2) Corner strips shall be welded continuously to the return and to the main liner and applied wherever possible from the back of the lining.
 - 3) Locking extensions shall be provided on returns to lock the returns to the concrete of plastic-lined, cast-in-place structures. Locking extensions will not be required on liner returns installed on lined precast concrete pipe and structures.
 - 4) Each liner shall be sealed to adjacent construction with which it is in contact as shown on the Plans or as approved by the DISTRICT COATINGS INSPECTOR.

D. Concrete Operations

1. Concrete Placement

- a. Concrete placed against liner shall be carefully vibrated to avoid damage to the liner and to produce a dense, homogeneous concrete securely anchoring the locking extensions into the concrete. External vibrators shall be used in addition to internal vibrators, particularly along the lower terminal edge of plastic liner.

2. Form Removal

- a. In removing forms, care shall be taken to protect liner from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the liner shall be pulled without tearing the liner and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and all areas of serious abrasion of the liner shall be marked.
- b. Banding straps used in securing liner to forms for cast-in-place structures shall be removed within the limits of the unlined invert, and voids left in the invert at the edge of the liner shall be filled with cement mortar or other material approved by the DISTRICT COATINGS INSPECTOR.

E. Field Joining of Liner

1. General.

- a. No coating of any kind shall be applied over any joint, corner or welding strip, except where nonskid coating is applied to liner surfaces.
- b. Adhesive shall not be applied to the surfaces of cement mortar in pipe joints, or to the surfaces of liner or joint strips opposite said mortar and concrete surfaces.
- c. Transverse joints are those perpendicular to the locking extensions.

2. Field Joints in Cast-in-Place Structures

- a. Field joints in liner on cast-in-place structures shall be one of the following types:
 - 1) **Type C-1.** A Type C-1 joint shall be made in the same manner as a Type P-1 joint is made. The width of the space between adjacent sheets of liner in a Type C-1 joint shall not exceed 2 inches. This type of joint is the only type permitted collateral with contraction joints in concrete. Its only other use is for joints between pipes and cast-in-place structures.
 - 2) **Type C-2.** A Type C-2 joint shall be made by overlapping sheets not less than 1-1/2 inches and securing the overlap to the adjacent liner by means of a welding strip. The upstream sheet shall overlap the downstream sheet. The length of that part of the overlapping sheet not having locking extensions shall not exceed 4 inches.
 - 3) A welding strip shall be applied to the back of the joint. This type of joint may be used at any transverse liner joint other than those collateral with contraction joints in concrete and shall be used for liner joints made at longitudinal joints in concrete.
 - 4) **Type C-3.** A Type C-3 joint shall be made by putting sheets of liner together and applying a welding strip over the back of the joint before concrete is placed, and applying a welding strip over the front of the joint after concrete is placed. A Type C-3 joint shall not be permitted at a transverse joint that extends to a lower terminal edge of liner or at any joint where the gap between adjoining sheets of liner exceeds 1/8-inch.
- b. Installation of Welding Strips
 - 1) Welding strips shall be fusion welded to joint strips and liner by qualified welders using only approved methods and techniques. The welding operation of any joint shall be continuous until that joint has been completed.
 - 2) At the lower terminal edges of liner, each transverse welding strip shall be extended at least 2 inches to provide a tab for testing the weld as described in the Section 3.8 B, Field Testing.
 - 3) Any weld strips or T-Lock sheets that have evidence of perforations due to overheating and deformation shall be removed and replaced.
- c. Joint Reinforcement
 - 1) A 12-inch long welding strip shall be applied as a reinforcement across each joint in liner that extends to the lower terminal edge of liner on each side of a pipe or structure. These reinforcement strips shall be centered over the joint being reinforced, shall be located as close to the lower edge of liner as practicable, and shall be welded in place after the transverse welding strips have been tested and the test tabs removed.

F. Protection and Repair of Liner

1. Repairing Small Holes, Cuts, and Tie-rod Holes

- a. Small holes or cuts in the T-Lock liner can normally be patched by welding a piece of flat weld strip over the hole or cut. Use 1-inch flat weld strip for

patching nail holes and cuts. Use 2-inch flat weld strip for tie-rod holes or larger holes that 1-inch wide will not cover. To insure proper coverage the width of the weld strip must be at least ½ inch greater than the width of the hole to be patched.

b. The procedure for patching small holes is as follows:

- 1) Start welding about 1 inch before the hole. Continue welding over the hole, centering the weld strip over the hole as closely as practical.
- 2) Weld about 1 inch beyond the end of the hole and trim the weld strip. When trimming the weld strip, be careful not to cut the underlying sheet.

2. Repairing Large Holes and Damaged Areas

a. Large holes and damaged areas can be repaired by carefully cutting out the damaged sheet, installing a new piece of liner to fill the void and welding the seam with 1-inch weld strip. The procedure for repairing large holes is as follows:

- 1) Using a sharp knife, cut away any loose or damaged T-Lock liner.
- 2) Cut a piece of plain sheet so that it completely covers the void area. The repair piece must be at least equal in thickness to the existing liner and must be butt or lap welded to the existing liner.
- 3) Attach the repair piece to the substance at the void area using T-Lock Liner 19Y Adhesive System.
- 4) Weld the seam between the existing T-Lock liner and the repair piece using 1-inch wide weld strip. See the instructions "Welding Procedure."

b. Placing flat weld strips side-by-side to patch larger holes is not recommended.

c. Patch material does not necessarily have to be square or rectangular, oval or round patch material may be used.

3. All necessary measures and precautions shall be taken to prevent damage to liner from equipment and materials used in, or taken through, the work. Any damage to installed liner shall be repaired by the CONTRACTOR in accordance with the requirements set forth herein for the repair of liner.

4. All nail and tie holes and all cut, torn, and seriously abraded areas in the liner shall be patched. Patches made entirely with welding strip shall be fused to the liner over the entire patch. The use of this method is limited to patches that can be made with a single welding strip. The use of parallel, overlapping or adjoining welding strips shall not be permitted. Larger patches may consist of smooth liner over the damaged area with edges covered with welding strips fused to the patch and to the liner adjoining the damaged area. The size of a single patch of the latter type shall be limited only as to its width, which shall not exceed 4 inches.

5. Wherever liner is not properly anchored to concrete, or wherever patches larger than those permitted above are necessary, the repair of liner and the restoration of anchorage shall be as directed by the DISTRICT COATINGS INSPECTOR.

G. APPLICATION OF PLASTIC LINER WITH ADHESIVES

1. Concrete Surfaces

- a. The installation of plain sheets shall not be permitted on concrete surfaces that are subject to intermittent or continuous immersion. It shall require prior approval by the District Representative. Areas that are immersed or non-immersed but in the head space of a structure, shall be protected with regular T-Lock lining.
- b. The concrete surface shall be etched by sandblasting to produce a surface that is equivalent to an ICRI 310.2 Concrete Surface Profile 3 or higher. Permits for the equipment and allowable methods from the SMAQMD shall be posted on or near sandblasting equipment as required.
- c. After the sandblasting, the concrete surface shall be thoroughly cleaned of dust. Surfaces etched with acid shall be thoroughly dried before applying primer.
- d. The concrete surface shall then receive two brush coats of an approved primer. Coverage shall not exceed 250 square feet per gallon for each coat of primer. The first coat of primer shall be thinned with an equal amount of approved thinner. The first primer coat shall be permitted to dry for at least 2 hours before the application of the second primer coat. The second coat of primer shall be applied unthinned and shall be permitted to dry for at least 4 hours.
- e. The concrete surface and the back surface of the liner shall each be given two coats of an approved adhesive. Two hours drying time shall be allowed between application of these coats. Coverage shall not exceed 250 square feet per gallon for each coat of adhesive.
- f. One coat of an approved activator shall be applied to both the adhesive coat on the liner and the adhesive coated concrete. Application of activator shall be limited to the extent that the application of coated liner can be completed within a 20-minute period. The activator shall be applied evenly by brushing. Coverage of the activator shall not exceed 500 square feet per gallon.
- g. When the surface of the adhesive is barely tacky to the touch, the liner shall be positioned with one edge firmly pressed down. The liner shall then be rolled into place. Care shall be taken to avoid the formation of air pockets. All joints shall be tight fitting butt joints. The surface of the liner shall be rubbed vigorously to secure the liner firmly in place.
- h. Corner and welding strips shall be positioned over all joints and welded in place.
- i. Any weld strips or T-Lock sheets that have evidence of perforations due to overheating and deformation shall be removed and replaced.

H. TESTING

1. Shop Testing

- a. All liner sheets shall be shop tested for holes, using an approved spark detector operating at a minimum of 10,000 volts. Sheets having holes shall be satisfactorily repaired in the shop and retested prior to shipping the sheets to the project site or the pipe manufacturing plant. Repairs shall be made only by welders prequalified as provided herein.

2. Field Testing

- a. When installing and welding are complete, the entire lining and weld areas shall be visually inspected and manually probed with a blunt instrument such as a putty knife. Any imperfections must be repaired before placing

the lining in service. The surface of liner shall be cleaned to permit visual inspection and spark testing. All welds shall be physically tested with a nondestructive probing method. All liner, when installed, shall be tested by the CONTRACTOR in the presence of the DISTRICT COATINGS INSPECTOR, using a holiday detector such as Elcometer 266-4, Tinker & Rasor Model AP-W, or equal set between 15,000 to 20,000 volts. All areas of liner failing to meet the field test shall be properly repaired and retested.

- b. The CONTRACTOR shall furnish a high-voltage detector for testing. The detector shall be set at 20,000 volts and a ground wire from instrument ground output terminal attached to the conductive substrate to ensure a positive electrical contact. When testing concrete surfaces, the ground wire shall be attached to the reinforcing steel. If they are not visible, the ground wire shall be placed directly against the bare concrete surface and weighted with a damp burlap or paper sand-filled bag.
- c. Periodically during the test, the exploring electrode should contact the conductive substrate to verify that the instrument is properly grounded. The exploring electrode should move over the surface of the dry liner at a rate of approximately 1 ft/sec (0.3 m/sec) using a single pass. Moisture on the coating surface may cause erroneous indications. If moisture exists, remove or allow the surface to dry before conducting the test.
- d. Discontinuities that require repair shall be identified with a marker that is compatible with the repair coating or one that is easily removed.
- e. All repairs to the liner shall be retested by the CONTRACTOR in the presence of the DISTRICT COATINGS INSPECTOR.
- f. Any spark testing of liner by the CONTRACTOR for the CONTRACTOR'S own purpose shall be done with a detector approved by the DISTRICT COATINGS INSPECTOR.
- g. Holiday testing shall be made following these procedures. Test for pinholes in the weld using an approved electrical holiday detector with the instrument set at 18,000 to 22,000 volts. Follow the instructions that come with the holiday detector. CAUTION: HIGH VOLTAGE – Electrical shock from this holiday detector may cause operators to injure themselves. Safety precautions must be observed. Read Instruction Manual. If pinholes are found at the edge of the weld strip, re-heat the area by fanning the air tool and immediately make several passes using the pressure roller to ensure the weld is complete. Note: Spark testing does not determine fusion of weld strip, it identifies pin holes.

- h. Each welding strip that extends to a lower edge of the liner shall be tested. The welding strips shall extend below the liner providing a tab. A 10-pound pull shall be applied normal to the face of the pipe or structure by means of a spring balance. Liner adjoining the welding strip shall be held against the concrete during application of the force. The 10-pound pull shall be maintained if a weld failure develops, until no further separation occurs. Defective welds shall be retested after repairs have been made. Tabs shall be trimmed away neatly by the liner installer after the welding strip has passed inspection. The CONTRACTOR shall provide all equipment required to test liner in the manner recommended by the manufacturer and as described above. The CONTRACTOR shall also provide personnel qualified to perform the testing. Testing shall be performed in the presence of the DISTRICT COATINGS INSPECTOR.

-END OF SECTION-

SECTION 07190 - WATER REPELLENTS

PART 1 GENERAL

1.1 THE REQUIREMENTS

A. Section Includes:

1. Section Includes: Water repellent for all exterior exposed concrete, complete.

1.2 DEFINITIONS

A. Water Repellent: Resistance to penetration of water from rainfall.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Surfaces with water repellent shall be uniform in color with unaltered texture.

1.4 SUBMITTALS

A. Product Data.

B. Samples: Water repellent applied on 8 inch by 8 inch substrates to receive water repellent, marked with application date and application rate.

C. Manufacturer's Application Instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of water repellents for minimum 5 years with satisfactory performance record.

B. Applicator Qualifications: Trained, approved, and accepted by water repellent manufacturer, and having minimum 2 years of experience spraying exotic coatings.

C. Regulatory Requirements: Comply with volatile organic compound regulations.

D. Mock-Ups:

1. Apply water repellent on 8 by 8 foot section of wall. Use same equipment and procedures that will be used in applying material on walls.
2. Test for water penetration in accordance with field quality control.
3. When accepted by the ENGINEER, mock-up walls will be standard for walls.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Apply water repellent under temperature and relative humidity conditions before, during, and after application in accordance with manufacturer's instructions. Allow surfaces to dry for minimum 5 days after rains.

- B. Make proper material allowance based upon substrate material and surface configuration when determining quantities of material.

1.7 WARRANTY

- A. Warrant to furnish and apply water repellent on walls that experience water penetration because of failure of water repellent for minimum 5 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Water Repellent Sealer:
 - 1. Manufacturers: One of the following or equal:
 - a. Rainguard Products, Inglewood, CA.
 - b. ProSoCo, Inc., Kansas City, KS.

2.2 MATERIALS

- A. Water Repellent Sealer for Concrete and Concrete Masonry: Silane/Siloxane; Volatile Organic Compound compliant; free of silicone oils, paraffin wax, or urethanes; one of the following or equal:
 - 1. Rainguard, BLOK-LOK.

2.3 EQUIPMENT

- A. Spray Equipment: High-volume, low-pressure, airless, with maximum 60 pounds per square inch pressure.
 - 1. Pump: Non-atomizing, able to flow material on walls at minimum 1 to 1-1/2 gallons per minute.
 - 2. Orifice Size for Concrete, Slump Block, Exposed Concrete Aggregate, and Cement Plaster: 0.060 to 0.110 inches.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect installed construction. Verify that construction is ready for repellent application. Require manufacturer's representative to verify that water repellent may be installed.

3.2 PREPARATION

- A. Allow concrete or masonry walls to cure at least 30 days before applying water repellent.
- B. Clean wall surfaces of soil, mud, efflorescence, or other detrimental materials.
- C. Tuck-point or caulk cracks, other than hairline cracks.
- D. Route out defective mortar joints, point with mortar and tool.

- E. Moisture Content: Apply water repellent sealer when moisture content of substrate is 15 percent or less.
- F. Test substrate surfaces for moisture content with "Electronic Moisture Register - Model B." Take 1 reading for each 200 square feet of wall area and tabulate results.

3.3 APPLICATION ON CONCRETE AND CONCRETE MASONRY

- A. Apply water repellent in accordance with manufacturer's printed instructions.
- B. Apply flood coat using low-pressure spray equipment.
- C. Start at top of wall and work down using overlapping horizontal passes.
- D. Hold spray head 8 to 10 inches from surface so saturation coat runs freely down wall 6 to 10 inches below point of application on most substrates.
- E. Spray by traveling horizontally to ensure uniform coverage.
- F. Overlap each following pass by centering spray head on bottom line of the previous pass.
- G. Trigger gun off at end of each pass to avoid applying excessive amount of material. Do not overapply.
- H. Avoid application in hot windy weather as premature drying can cause whitish residue on walls.

3.4 FIELD QUALITY CONTROL

- A. Test water repellent with running water 20 days after application.
- B. Notify the ENGINEER and manufacturer at least 72 hours in advance of test. Conduct test in the ENGINEER's and manufacturer's presence.
- C. Use 3/4-inch garden hose with garden type spray nozzle, and outrigger or similar acceptable equipment. Place 8 to 10 feet from wall where designated by the ENGINEER. Aim nozzle so water strikes wall at 45-degree downward angle.
- D. Run water onto wall at full available force for minimum 4 hours. Make provisions to collect run off water into containers for possible reuse.
- E. Inspect interior surface of wall for evidence of moisture penetration.
- F. Where evidence of moisture penetration is discovered, apply additional coat of water repellent on entire wall from corner to corner.
- G. Test other locations where directed by the ENGINEER.

3.5 CLEANING

- A. Concrete: Clean drips, runs, and overspray residue while still wet, using detergent and water. Clean application and spray equipment with detergent and water immediately following use.

- B. Clean application and spray equipment according to the manufacturer's recommendations.
- C. Remove excess materials, equipment, and debris incidental to water repellent application upon completion.

3.6 PROTECTION

- A. During application, protect water repellent treated and adjacent surfaces from damage.
- B. Protect glass, aluminum, and other surfaces from overspray.
- C. Protect concrete sidewalks from runoff. Soak with water immediately prior to application on adjacent walls.
- D. Repair damaged areas promptly.

END OF SECTION

SECTION 07600 - FLASHING AND SHEET METAL

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Flashing and sheet metal work, complete, including, but not necessarily limited to, the following items:
 - 1. Flashing and counterflashings over penetrations for mechanical equipment, vent stacks, etc.
- B. Related Sections:
 - 1. Section 07920 - Sealants and Caulking .
 - 2. Section 09960 – Protective Coatings: Prime and finish painting.
 - 3. Division 15 - Mechanical: Flashing sleeves and collars for mechanical items protruding through roof.
 - 4. Division 16 – Electrical: Flashing sleeves and collars for electrical items protruding through roof.

1.2 SUBMITTALS

- A. Shop Drawings: Submit fully detailed, large-scale shop drawings of all fabricated items. Including all flashing and counterflashings. Describe material profile, jointing pattern, jointing details, fastening methods, and installation details.

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications: Company experienced and specializing in sheet metal flashing work.
- B. Standards: Conform to the applicable provisions of the "Architectural Sheet Metal Manual", latest edition, as issued by the Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA).

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation.
- B. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel: ASTM A653, G90; 24-gage core steel; minimum 27 percent post-consumer recycled content; typical at all flashings and counterflashings.
- B. Elastomeric Flashing: Modified bituminous sheet rubber, self-adhesive-backed rubberized asphalt, in continuous length x widths as required; W.R. Grace "Vycor V40", Johns Manville, or equal. Provide where shown on the Drawings.
- C. Screws and Fasteners: Same material as sheet metal or material being fastened; hot-dip galvanized or stainless steel.
- D. Solder:
 - 1. For Stainless Steel: ASTM B32; 60 percent tin, 40 percent lead, with acid-chloride type flux, except use rosin flux over tinned surfaces.
 - 2. For Galvanized Steel: ASTM B32; 50 percent tin, 50 percent lead, with rosin flux.
- E. Cleats: 2-inch wide x 3-inch long, unless otherwise indicated. Fabricate from same material and gage as sheet metal being installed.
- F. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessories as required for installation of work, matching or compatible with material being installed, non-corrosive, size and gage as required for performance.
- G. Galvanized Repair Paint: Zinc-rich repair paint, Z.R.C., Cold Galvanizing, Tnemec-zinc 92, or equal.
- H. Elastomeric Sealant: ASTM C920, polyurethane or silicone sealant, of type and class required to seal joints in sheet metal flashing and trim, and remain watertight.

2.2 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects. Form pieces in longest practical lengths. Seal metal joints with sealant.
 - 1. Cleats and Starter Strips: Fabricate of same material as sheet, minimum 3 inches long, interlockable with sheet.
 - 2. Exposed Edges: Hem on underside 1/2 inch; miter and seam corners. Form material with flat lock and cover plate seam, as shown.
 - 3. Corners: Fabricate from one piece with minimum 24 inch long legs; mechanically fasten and solder watertight.
 - 4. Vertical Faces: Fabricate with bottom edge formed outward 1/4 inch and hemmed to form drip.

5. Counterflashings: Fabricate to allow toe to extend 4 inch minimum over roofing surface. Return and brake edges.

2.3 FINISHES

- A. Exposed Surfaces: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for applying and designating finishes. Protect prepainted finishes on exposed surfaces with a strippable temporary protective covering.
- B. Concealed Surfaces: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting with bituminous coating. Apply a minimum of 15 mils dry film thickness.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Field measure site conditions prior to fabricating work. Install starter and edge strips, and cleats before starting installation.

3.2 INSTALLATION

- A. General: Apply all work to even, smooth, sound, thoroughly clean, and dry surfaces free from defects. Install all work plumb and securely fastened for watertight installation. Provide accessories and other items essential to completion of work, though not specifically shown or specified.
- B. Install sheet metal according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Conform to drawing details included in SMACNA manual. Install self-adhesive membrane flashings prior to or in conjunction with sheet metal items as shown on the Drawings.
- C. Attachments: In general, confine attachments of sheet metal less than 12 inches wide to one edge only. Space screws or nails evenly and approximately 4 inches apart. Where sheet metal is applied to surfaces other than wood, provide shop drawings to establish locations for sleepers and nailing strips required to secure the work properly.
- D. Soldering: Solder metal joints watertight for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.
- E. Expansion and Contraction: Provide expansion and contraction joints at all sheet metal work. Unless otherwise specified or indicated, make up long straight runs of sheet metal work in 12 foot lengths maximum, and connect together with 3 inch loose-lock slip-type joints, and fill with sealant as specified. For straight runs less than 12 feet but more than 8 feet, make a similar slip-type joint at center of run. Lock and solder seams of intermediate joints between expansion joints.
- F. Flashings:

1. Provide flashings, where shown or required, to provide watertight protection; use galvanized sheet metal, unless otherwise indicated on Drawings.
2. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations approved by Engineer.
3. Fit flashings tightly in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

G. Counterflashings:

1. Provide counterflashings at intersections of roof with vertical surfaces and similar conditions. Secure to vertical surfaces as detailed.
2. Turn down counterflashings over base flashings not less than 4 inches; form to provide a spring action against base flashing or roofing.
3. Overlap joints a minimum of 4 inches and bed with elastomeric sealant. Provide prefabricated end closures.

H. Equipment Support Flashing: Coordinate installation of support flashing and counterflashing with installation of roofing and items. Weld or seal flashing to support members with elastomeric sealant.

END OF SECTION

SECTION 07920 - JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Preparation of sealant substrate surfaces, and providing of sealant and backing materials, complete.
- B. Related Sections:
 - 1. Section 08800 - Glazing: Sealants used in conjunction with glazing.

1.2 SUBMITTALS

- A. Product Data: Submit product data indicating sealant chemical characteristics, performance criteria, limitations, and color availability for each condition and use. Manufacturer's Data: Submit manufacturer's specifications, recommendations, and installation instructions, including cleaning of joint surfaces, for each type of material required.
- B. Samples: Submit samples of each color required for each type of exposed sealant. Samples will be reviewed by Architect for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
- C. Certificates: Submit manufacturer's certificate that sealants meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications: Experienced and specializing in applying the Work of this Section, and approved by sealant manufacturer.
- B. Regulatory Requirements: For interior applications use sealants and sealant primers that comply with South Coast Air Quality Management District (SCAQMD) Rule #1168, effective July 1, 2005 and rule amendment date of January 7, 2005. Meet the following VOC limit in grams per liter less water, when calculated according to 40 CFR 59:
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Quality Control: Comply with manufacturer's printed instructions for surface preparation, priming, installation, tooling, and curing, except where more stringent requirements are specified.

1.4 PROJECT CONDITIONS

- A. Do not install solvent-curing sealants in enclosed building spaces.
- B. Weather Conditions: Do not proceed with installation of sealants under adverse weather conditions or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength. Wherever joint width is affected by ambient temperature variations, install sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range.

1.5 WARRANTY

- A. Provide ten (10) year warranty. Include coverage of installed sealants and accessories which fail to achieve air-tight and water-tight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

- A. General:
 - 1. Compatibility:
 - a. Before purchase of each required material, confirm its compatibility with every other material to which it will be applied in the joint system.
 - b. Where more than one sealant material is in contact or potentially in contact with another, provide sealant materials which are compatible with each other.
 - c. Where specified butyl-rubber sealant is to be in contact with silicone sealant, provide silicone sealant instead of the specified butyl-rubber sealant.
 - d. Where sealant is in contact with waterproof membranes, provide sealant which is compatible with the membrane and approved by the membrane manufacturer.
 - 2. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59:
 - a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
 - 3. Colors: For concealed material provide any of manufacturer's standard colors; for exposed material provide manufacturer's standard colors as selected by ENGINEER, unless otherwise noted.
- B. Exterior Concealed Sealant for Bedding Purposes: Single-component butyl sealant, solvent release, non-skinning, non-sagging; meeting FS TT-S-001657; DAP "Butyl-flex", Bostik "Chem-Calk 300", or equal.

- C. Exterior Exposed Joints for General Use: Single-component nonsag polyurethane sealant; meeting ASTM C920, Type S, Grade NS, Class 25; Sika Corporation "Sikaflex-1a/15 LM", Tremco "Dymonic FC", Pecora "Dynatrol I", or equal.
- D. Exterior Exposed Joints of Nonporous Substrates (Glass, Metals, etc.): Single-component acid-cure silicone sealant; meeting ASTM C920, Type S, Grade NS, Class 25; Dow Corning "795 Glass and Metal Building Sealant," G.E. "Silpruf," or equal.
- E. Horizontal Traffic Joints, Interior or Exterior: Single-component pourable polyurethane sealant, self-leveling, color to match adjacent surfaces or grout color; meeting ASTM C920, Type S, Grade P, Class 25; Tremco "Vulkem 45," Sonneborn "Sonolastic SL 1," or equal.
- F. Interior Non-wet, Non-moving Joints: Single-component acrylic emulsion latex, non-staining, non-bleeding, non-sagging; color as selected; meeting ASTM C834; DAP "Acrylic Latex Caulk", Pecora "AC-20", Tremco "Tremflex 834", or equal.

2.2 ACCESSORIES

- A. Primer: Non-staining type, VOC compliant, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, VOC compliant, recommended by sealant manufacturer; compatible with joint-forming materials.
- C. Joint Backing Rod: Preformed; compressible; resilient; non-staining round backer rod; compatible with joint substrates, sealants, and primers; as recommended by sealant manufacturer for type of sealant; oversized 30 to 50 percent larger than joint width; meeting ASTM D1056.
 - 1. Typical Joints: Closed cell polyethylene or polyurethane foam.
 - 2. Horizontal Joints Exposed to Water: Closed cell polyethylene foam, non-absorbent to water, non-outgassing in unruptured state.
- D. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine the substrates and the conditions under which sealant work is to be performed. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Verify that surfaces and joint openings are ready to receive work and field measurements are as shown on Drawings and recommended by the manufacturer. Start of installation means the condition of existing surfaces has been accepted.

3.2 PREPARATION

- A. Clean joint surfaces immediately before installation of sealant. Remove dirt, insecure coatings, moisture, and other substances which could interfere with bond of sealant compound. Etch concrete joint surfaces as recommended by sealant manufacturer. Use cleaning solvent to clean all joint surfaces. Wipe joints free of solvent using clean, dry, white cotton cloths or white, lintless paper. Do not permit solvent to air dry.
- B. Prime or seal the joint surfaces. Do not allow primer/sealer to spill or migrate onto adjoining surfaces. All anodized aluminum surfaces to receive sealant shall be primed with primer recommended by the sealant manufacturer, unless sealant manufacturer certifies in writing that primer is not required.
- C. Install sealant backer rod for elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown, or when backed by other solid substrate.
- D. Install bond-breaker tape wherever backer rod is not used and wherever required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.
- E. Verify that joint backing and release tapes are compatible with sealant.
- F. Protect elements surrounding the work of this Section from damage or disfiguration.

3.3 INSTALLATION

- A. Install sealants in accordance with manufacturer's written instructions, unless more stringent requirements are indicated or specified.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Measure joint dimensions and size materials to achieve required width/depth ratios.
- D. Install joint backing to achieve a neck dimension no greater than 1/2 the joint width. Neck dimension to be a minimum 1/4 inch and a maximum 1/2 inch. Install bond breaker where joint backing is not used.
- E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.
- G. In exterior work where sealant tape is used, provide cap sealant bead of the specified silicone sealant.

- H. Install sealant around all doors, windows and around all observable sources of air leakage from the building.
- J. Cure sealants in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.

3.4 CLEANING AND REPAIRING

- A. Do not allow sealants or compounds to overflow or spill onto adjoining surfaces or to migrate into the voids of adjoining surfaces. Clean the adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.
- B. Repair or replace defaced or disfigured finishes caused by work of this Section. Protect sealants until cured.

END OF SECTION

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SECTION 08254 - PRE-ASSEMBLED PLASTIC DOOR ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes: Non-fire rated and fire rated plastic door assemblies, including frames and flush doors with glazed lights and louvers.
- B. Related sections:
 - 1. Section 08710 - Door Hardware.
 - 2. Section 08800 - Glazing.

1.2 SUBMITTALS

- A. Product data.
- B. Shop drawings: Show door and frame types; fabrication details, including internal blocking for hardware; hardware locations; and door locations, referenced to Engineer's door marks and hardware groups.
- C. Samples: Typical corners, minimum 6-inch long horizontal and vertical members, showing construction texture and finish color.
- D. Manufacturer's instructions: Submit manufacturer's installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to and at project site in accordance with manufacturer's instructions.
- B. Mark each door and frame wrapping with type, size, and location for installation.
- C. Deliver items to site when facilities are available for handling, sorting and protecting items, when receiving areas are broom-cleaned, and when exterior openings are closed up and wet work is complete.
- D. Provide temporary protective wrapping for items during delivery, installation, and until final acceptance.
- E. Store at project site under cover.
 - 1. Prevent water damage.
 - 2. Avoid non-vented plastic or canvas shelters that create humidity chamber.
 - 3. Provide minimum 1/4-inch space between items to promote air circulation.
- F. When door wrappers become wet, remove immediately.

1.4 PROJECT CONDITIONS

- A. Environmental requirements: Provide manufacturer's recommended heat and humidity in area of installation and storage.

1.5 SEQUENCING AND SCHEDULING

- A. Ensure timely delivery of reviewed hardware schedule and hardware templates such that no delay occurs in the Work.

1.6 WARRANTY

- A. Warrant to repair or replace defective doors and frames in accordance with manufacturer's standard 5-year warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Packaged plastic door assemblies: One of the following or equal:

1. Chem-Pruf Door Company, Brownsville, TX.
2. Corrim Company, Oshkosh, WI.

2.2 MATERIALS

- A. Plastic: Fiberglass reinforced plastic, corrosion-resistant isophthalic polyester resin system with light stabilizing additives, reinforced with fiberglass; formulated to provide corrosive and chemical resistance to specific operating environments.
- B. Core material:
 1. Non-Fire Rated: End grain balsa wood, 8.5 to 9.0 pounds per cubic foot density, minimum 1,400 pounds per square inch compressive strength perpendicular to door panel surface.
- C. Stiles and rails:
 1. Non-Fire Rated: Pultruded plastic tubes, 1-1/2 inches square, capable of being reduced 1-1/4 inches in height when used as bottom rail without loss of integrity.
- D. Reinforcement and corner block material: Solid blocks of polyester based resin filled with minimum 1/8-inch chopped glass strands and aerocil, sizes as required.
- E. Chemical welding material: Manufacturer's standard.
- F. Glass: Clear float, fully tempered, as specified in Section 08800.
- G. Glazing materials: As recommended by manufacturer.
- H. Anchors and fasteners: Stainless steel, manufacturer's standard sizes and shapes.

- I. Door hardware: As specified in Section 08710.

2.3 DOOR PANELS

- A. Type A: Flush, 1-3/4 inch thick, non-fire rated, minimum 1/8-inch thick plastic face sheets chemically welded and sealed to each side of core material, hardware reinforcement, and continuous stile and rail structural system.
- B. Door edges: Beveled minimum 1/8 inch in 2 inches.
- C. Glazing: Standard vision light with polymer mouldings and stainless steel screws.
- D. Transoms: Same stile, rail, core material, and face sheets as door panels, reinforced with non-swelling polymer blocks where through bolts are used to attach to frame.

2.4 FRAMES – NON-FIRE RATED

- A. Type: One-piece with integral stops.
- B. Profile:
 - 1. Jamb depth: 5-3/4 inches.
 - 2. Face dimension: 2 inches.
 - 3. Return: 1/2 inch.
 - 4. Rabbet: 5/8 by 1-15/16 inches.
- C. Material: Pultruded plastic sheet.
- D. Corner construction: Mitered, reinforced with pultruded plastic angle, attached with stainless steel screws.
- E. Corner reinforcement: Plastic angles, 4- by 4- by 5-3/8- by 1/4-inch thick, attached with stainless steel screws.
- F. Mortise and surface hinge reinforcement: polymer, 5-1/4- by 8- by 1/4-inch thick, attached to frame by bonding and with stainless steel countersunk screws and screw covering.
- G. Closer reinforcement: Polymer, 1-1/2- by 8- by 3/4-inch thick, attached to frame by bonding and stainless steel countersunk screws and screw covering.
- H. Jamb anchors: Minimum 3 per jamb at maximum 24 inches on center, type as required for adjacent wall construction:
 - 1. Type for wall abutting frames: Machine screw and shield through plastic tube welded to frame and extending to wall with plastic pressure button bedded in silicone sealant that conceals anchor hole in stop.

- I. Floor anchors: Plastic angle, 1/4-inch thick, welded to frame or inserted in frame slot and anchored to floor through minimum 2 holes, 1 per jamb.

2.5 HARDWARE PREPARATION – NON-FIRE RATED

- A. Prepare and reinforce doors and frames with solid reinforcement material for hinges, locksets, strikes, closers, and other items as required.
- B. Provide doors and frames with cutouts and solid reinforcement material for mortise hardware and solid reinforcement material for surface mounted hardware in accordance with manufacturer's templates.
- C. Drill and tap for hardware.
- D. Make total thickness of solid reinforcement greater than nominal depth of fasteners required by hardware items, unless greater thickness is recommended by manufacturer.
- E. At doorframes not to receive weather stripping, drill doorframes for installation of minimum 3 silencers in jamb stops of single leaf doors and 2 in head stop of double-leaf openings.

2.6 FINISHES

- A. Finish: Smooth seamless finish with 25 mil thick color impregnated gel coat integrally molded into both door and frame.
- B. Finish colors:
 - 1. Doors: To be selected by ENGINEER.
 - 2. Frames: To be selected by ENGINEER..

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine hardware schedules and coordinate hardware with doors and frames.
- B. Examine opening locations and verify following:
 - 1. Correctness of dimensions, backing, or support conditions.
 - 2. Absence of defects that would adversely affect frame or door installation.

3.2 INSTALLATION – NON-FIRE RATED

- A. Install doors assemblies in accordance manufacturer's instructions.
- B. Set frames accurately in position, plumb, aligned, and attached securely to structure.

- C. Set frames in position, plumbed, aligned, and securely braced until permanent expansion anchors are set.
 - D. Anchor frames to previously placed concrete with countersunk machine screws through the frame into expansion devices spaced at minimum 30 inches on center.
 - E. Install doors at openings. Ensure smooth swing and proper closure with frame.
 - F. Install door hardware as specified in Section 08710.
- 3.3 ADJUSTING
- A. Make adjustments as required for correct, proper, and free function and smooth operation without binding of hardware, doors, and frames.
- 3.4 CLEANING
- A. Clean doors assemblies prior to final acceptance with materials and methods as recommended by door manufacturer.
- 3.5 PROTECTION
- A. Protect doors assemblies from damage to surface or profile.

END OF SECTION

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SECTION 08710 - DOOR HARDWARE

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Section Includes:

1. All necessary door hardware to complete the Project, except those items specifically mentioned to be furnished by other Sections.
2. Wherever items of door hardware are not definitely specified but are required for proper completion and/or operation of doors, or a hardware item may no longer be available, furnish hardware in type, quality, and finish suitable for the service required and comparable to that specified for similar conditions, and notify the Engineer immediately.

1.2 RELATED WORK SPECIFIED ELSEWHERE

1. Section 08254, Pre-Assembled Plastic Door Assemblies

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Builders Hardware Manufacturers' Association (BHMA).
- B. Door and Hardware Institute (DHI).
- C. National Association of Architectural Metal Manufacturers (NAAMM).
- D. National Fire Protection Association (NFPA):
 1. NFPA 80 - "Fire Doors and Windows".
 2. NFPA 101 - "Life Safety Code".

1.4 SUBMITTALS

- A. Hardware Schedule: Submit a complete schedule of door hardware for review. Reference items clearly to groups specified, door-type designations shown, location, and other pertinent data. Verify suitability, function, thickness of members, or other factors affecting appropriate selection. List manufacturer's names or suitable abbreviation to facilitate reviewing, opposite each item scheduled.
 1. List only readily obtainable hardware that appears in current catalogs. Do not deliver hardware until schedule has been accepted by the Engineer.
 2. After the hardware schedule is accepted by the Engineer, provide one copy

of the accepted hardware schedule to each trade whose work may be affected.

- B. Product Data: Submit catalog cuts and product data on each different type of hardware included in hardware schedule. Indicate locations and mounting heights of each type of hardware. Submit manufacturer's parts lists, templates, and installation instructions.
- C. Samples: Prior to delivery of any hardware to the site, submit one sample of each class or type of hardware to the Engineer for final review. Affix labels to fully identify manufacturer, class or type, and location on the Project. After review, accepted samples may be obtained from the Engineer for installation on the Project, providing such samples are picked up within seven days of notification of acceptance.
- D. Operation and Maintenance Data: Submit operation and maintenance data. Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

1.5 QUALITY ASSURANCE

- A. Supplier Qualifications: Company experienced and specializing in supplying commercial door hardware. The hardware supplier shall employ a member of the Door Hardware Institute (DHI) who is a Certified Architectural Hardware Consultant (AHC) to prepare the hardware schedule submittal and, upon completion of the building, check the installation and disclose any misapplication of hardware.
- B. Regulatory Requirements:
 - 1. Egress Doors: Comply with CBC Section 1008 and applicable requirements of NFPA 101 "Life Safety Code".

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hardware with items packed separately, complete and ready for installation with necessary fittings, trim, fasteners, and accessories. Mark packages clearly for identification in accordance with Hardware Schedule. Deliver hardware so that work may progress without delay or interruption.
- B. Package all items of hardware and each lockset, latchset, exit device, and door control/closer in its individual package marked with manufacturer's name, type number, and name of item. Furnish each item complete with necessary fastenings, wrenches, spanners, installation instructions, and templates. Indelibly, legibly, and carefully mark each package with an item number corresponding to the door number and hardware group number as indicated on the opening schedule, the approved door Hardware Schedule, and the Drawings and details.
- C. Protect hardware from damage before, during, and after installation.

1.7 COORDINATION

- A. Coordinate work of this Section with other directly affected Sections involving manufacturer of any internal reinforcement for door hardware.
- B. Manufacture all hardware to template. Provide templates and, if necessary, the physical hardware to fabricator of doors and frames in ample time to facilitate the work.
- C. Coordinate electrical and security requirements of hardware items with related sections.

1.8 WARRANTY

- A. Provide extended warranty for the following hardware items in accordance with requirements of Division 1. Warrant that hardware shall be free of defects in material and workmanship and that it will not deteriorate excessively, or otherwise fail to perform as required.
 - 1. Hinges: Life of building.
 - 2. Door Closers: Ten years.
 - 3. Locks: Five years.

1.9 MAINTENANCE MATERIALS

- A. Provide special wrenches and tools applicable to each different or special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. General: Numbers in Hardware Schedule refer to those of the first named manufacturer below. Equivalent products by the other named manufacturers are also acceptable, or equal.
- B. Butt Hinges: Stanley (STA), Hager, Lawrence, McKinney.
- C. Pivots: Rixson (RIX), Dor-O-Matic.
- D. Locksets and Latchsets: Schlage (SCH).
- E. Aluminum Door Locks: Adams Rite (AR).
- F. Cylinders: Schlage (SCH), Best.

- G. Exit Devices: Von Duprin (VON), Precision Hardware Inc.
- H. Overhead Closers: LCN, Dorma, Norton.
- I. Flush Bolts and Coordinators: Ives (IVE), Door Controls Inc.
- J. Stops: Ives (IVE), Trimco.
- K. Gasketing and Thresholds: Pemko (PEM), Reese, Zero.
- L. Protection Plates and Push/Pull Plates: Ives (IVE), Trimco.

2.2 HINGES

- A. Standard: Meeting ANSI A156.1, Grade 1.
- B. Type: Butt hinges of the five-knuckle, full mortise type, minimum of two bearings, stainless steel pins, and as follows:
 - 1. Outswinging Doors:
 - a. To the Exterior: Stainless steel or non-ferrous material, with nonremovable pins (NRP) of the setscrew type.
- C. Hinge Size:
 - 1. Doors 1-3/4" thick and up to 37" wide: 4-1/2 x 4-1/2 inch butt hinges provided with at least two ball bearings or life-span bearings.
 - 2. Doors over 1-3/4" thick or over 37" wide: 5 x 4-1/2 inch extra-heavy duty butt hinges provided with at least four ball bearings.
 - 3. Butt hinges for doors thicker than noted above or with unusual trim conditions which would interfere with the full opening of the door shall be provided with hinges of sufficient size to adequately support the door weight and of sufficient width to clear adjacent trim.
- D. Number of Hinges Per Door Leaf:
 - 1. Doors up to 60 Inches High: Two hinges per door leaf.
 - 2. Doors up to 90 Inches High: Three hinges per door leaf.
 - 3. Doors over 90 Inches High: Three hinges plus one additional butt hinge for each additional 30 inches in height over 90 inches, or fraction thereof.

2.3 LOCKSETS, LATCHSETS, AND CYLINDERS

- A. Standards:

1. Cylindrical Locks: Meeting ANSI A156.2, Series 4000, Grade 1.
- B. Lock Type: Where locksets or latchsets are scheduled, provide Schlage "ND" Series, cylindrical type locks, with backsets of 2-3/4 inches, unless otherwise noted. Provide all locks for the entire Project from the same manufacturer.
- C. Design: Lever handles, Schlage "Rhodes" design, unless otherwise noted.
- D. Strikes: Provide each lockset, latchset, or deadlock with a strike and a strike box. Provide standard type strikes with extended lips where required to protect adjacent trim from being marred by latch bolt. Verify cutout types provided in metal frames.
- E. Construction Cylinders: Provide construction keying for cylinders as required and keys for use during construction. Remove construction plugs upon completion of project, allowing Owner to use final keyed cores.

2.4 DOOR CLOSERS

- A. Standards: Meeting ANSI A156.4, Grade 1, and 2000 UBC Standard 7-2 - positive pressure test.
- B. Type: Rack and pinion construction, steel spring, fully hydraulic action, non-handed, cast iron or cast aluminum body, non-gumming, non-freezing hydraulic fluid requiring no seasonal adjustment for temperature.
- C. Closer Force: Capable of having spring force increased by 50 percent by adjustment without removing from the door, and effecting a maximum operating pressure on the door as follows:
 1. Interior Doors: 5.0 pounds.
 2. Exterior Doors: 8.5 pounds.
 3. Fire Doors: 15 pounds.
- D. Overhead Surface-Mounted Closers:
 1. Out-swinging Doors to the Exterior and into Corridors: Parallel arm closers, with the closer mounted on the inside of the door.
- E. Features: Positive back-check action near the outer limit of the opening cycle, properly located so as to protect door, frame, trim, and hardware; separate adjustments for latch speed, general speed, and back check; hydraulic regulation by tamperproof, noncritical screw valves adjustable only with a hex wrench. Where called for, provide closers with built-in positive stop.

2.5 AUXILIARY HARDWARE

- A. Standards: Meeting ANSI A156.16.
- B. Door Stops: Floor type or wall bumper type as scheduled. Provide each door leaf

with a stop of proper size and height to prevent door from hitting wall or fixed objects. Built-in stops in door closers and overhead stops, where called for, shall satisfy this requirement.

1. Wall Stops: No visible fasteners.
 2. Floor Stops: Of height required by floor conditions, fastened by means of machine screws and expansion anchors.
- C. Silencers: Gray rubber, non-marring configuration for metal or wood doors. Provide each door with a pressed-metal frame with tamper resistant rubber silencers. Provide each single door with three silencers, each pair of doors with four. Omit at doors to receive gasketing.

2.6 THRESHOLDS, DOOR BOTTOMS, AND GASKETING

- A. Provide as scheduled and detailed. Install with countersunk, flat-head screws, of same material and finish as item being attached at all applied thresholds, door bottoms, stops, and door gasketing.

2.7 DOOR PLATES

- A. Standards: Meeting ANSI A156.6.
- B. Protection Plates: Stainless steel, with beveled edges, as scheduled and detailed.
1. Thickness: Minimum of 0.050-inch.
 2. Width: Protection plates shall be 1-1/2-inch less than door width at single doors, 1-inch less than leaf width at pairs of doors.
 3. Height: Kickplates shall be 10 inches high. At surface-applied drop seal conditions, extend kickplate from top of drop seal to 12 inches above finished floor.
- C. Combination Push-Pull Plates: Minimum 0.050-inch thick, stainless steel, beveled edges.
- D. Install plates using countersunk spanner-type stainless steel #6 oval head screws.

2.8 KEYS AND KEYING

- A. Meet with Owner to determine final keying requirements. Key the building to match Owner's existing system, as directed by Owner.
- B. Key Type: Schlage 6-pin non-removable core system.
- C. Grand Master Key (Opens every door): 4 keys
- D. Identification: Emboss face of each cylinder plug and key with minimum 3-digit

visual key control system. Stamp all keys "DO NOT DUPLICATE".

- E. Coordinate with Owner the changeover to permanent cores at completion of Project.
- F. Provide a construction keying system for Contractor's and/or Owner's use as required during construction. Remove temporary construction plugs upon completion of construction.

2.9 FINISHES

- A. Typical Hardware:
 - 1. Typical Interior Locations: BHMA 626 or 652 (US26D) – dull chromium-plated, unless noted otherwise.
 - 2. Exterior Locations: BHMA 630 (US32D) – satin stainless steel, unless otherwise noted.
- B. Thresholds: BHMA 719 – mill finish extruded aluminum.
- C. Weatherstripping and Gasketing: BHMA 628 (US28), clear anodized aluminum, unless otherwise noted.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine doors, frames, and other surfaces to receive door hardware and report all defects which might adversely affect the installation or function of the hardware. Do not begin installation until unsatisfactory conditions have been resolved.
- B. Coordinate and be responsible for the proper fabrication of all work or material to receive hardware. No extra cost will be allowed because of changes or corrections necessary to facilitate the proper installation and operation of the hardware.

3.2 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and requirements of ANSI/NFPA 80, and DHI. Use templates provided by hardware item manufacturer.
- B. Accessibility: Conform to CBC and ADAAG requirements for positioning and installing hardware.
- C. Hardware: Provide with all necessary screws, bolts, and other devices or fastenings of suitable size and type to secure the hardware in position for heavy use and long life, harmonizing as to material and finish. Furnish fasteners, where necessary, with expansion shields or other approved anchors according to the material to which it is applied and as recommended by the manufacturer. Secure hardware to

concrete with expansion sleeve anchors as indicated by best current practice; plastic or "Rawl" plugs will not be accepted. Provide full-threaded hardware screws of sufficient length to firmly engage backing. Screws shall have "Phillips" heads, finished to match hardware.

- D. Thresholds: Set in bead of sealant.
- E. Keying: Coordinate with the Owner the changeover to permanent cores at completion of Project.

3.3 MAINTENANCE RELATED ITEMS

- A. Furnish one set of installation and adjusting tools and one set of maintenance manuals for locksets, exit devices, door controls/ closers, and floor hinges to the Owner.

3.4 ADJUSTMENTS AND INSPECTION

- A. Closers: Regulate and adjust to comply with fire and accessibility requirements prior to final inspection.
- B. During the installation of hardware a periodic inspection shall be made by the Contractor in company with a representative of the Engineer and the hardware supplier or his agent. Remove and reinstall hardware improperly installed, at no additional cost to Owner. At completion of the work a final inspection shall be made by the above parties. Make adjustments recommended by any of the above parties.

3.5 HARDWARE SCHEDULE

- A. General: The accompanying Hardware Schedule is furnished for whatever guidance and assistance it may afford the Contractor but shall not necessarily be considered as entirely inclusive. Examine the Drawings and the Specifications to determine the extent, quality, and function of hardware required. Furnish all necessary architectural finish hardware to complete the work.
- B. Should any door or item be inadvertently omitted from the scheduled hardware, provide such door or item with the same hardware as required for similar purposes. Should it be determined that the hardware scheduled is not suitable due to detail or size of member, provide hardware of proper size, type and function, similar in operation and equivalent to that specified.
- C. Whether listed or not, provide latching lockset, door closer, and smoke gasketing at all fire-labeled doors.

3.6 DOOR HARDWARE SCHEDULE

<u>MFR</u>	<u>QUAN</u>	<u>ITEM</u>	<u>NUMBER</u>	<u>FINISH</u>

HARDWARE GROUP 1 (Pr. Exterior FRP Electrical Room Doors)

STA	3	Pr. Butts	FBB199 x NRP, 4-1/2 x 4-1/2	630
VON	1	Exit Device	9875L	630
SCH	1	Lockset	L9456P X 06A	626
GJ	1	Set Auto Flush Bolts	FB31P	626
GJ	1	Dustproof Strike	DP1	626
GJ	1	Coordinator	COR-2 x Filler Bar	626
LCN	2	Closers	4041H-CUSH x 4040-3049CNS arm	689
PEM	1	Threshold	170A	719
PEM	1	Weatherstrip	303AS	719
PEM	1	Astragal	355CS	628
PEM	2	Door Bottoms	216AV	719

HARDWARE GROUP 2 (Exterior FRP Exit Door)

STA	1-1/2	Pr. Butts	FBB199 x NRP, 4-1/2 x 4-1/2	630
VON	1	Exit Device	9875L	630
SCH	1	Lockset	L9456P X 06A	626
LCN	1	Closer	4041H-CUSH x 4040-3049CNS arm	689
PEM	1	Threshold	170A	719
PEM	1	Weatherstrip	303AS	719
GJ	1	Lock Protector	LP1	630
PEM	1	Door Bottom	216AV	719
TRI	1	Door Holder & Strike	1265	626

-END OF SECTION-

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SECTION 08800 – GLAZING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Glass and glazing accessories for transom windows.
- B. Related Sections:
 - 1. Section 07920 – Sealants and Caulking
 - 2. Section 08110 – Steel Doors and Frames .

1.2 REFERENCES

- A. American National Standards Institute (ANSI) Z97.1 - Glazing Material Used in Buildings - Safety Performance Specifications and Methods of Test.
- B. ASTM International (ASTM):
 - 1. C 920 - Elastomeric Joint Sealants.
 - 2. C 1036 - Flat Glass.
 - 3. C 1048 - Heat-Treated Flat Glass-Kind HS and Kind FT, Coated and Uncoated Glass.
 - 4. C 1281 - Preformed Tape Sealants for Glazing Applications.
 - 5. C 1376 - Pyrolitic and Vacuum Deposition Coatings on Glass.
 - 6. E 774 - Classification of the Durability of Sealed Insulating Glass Units.
- C. Glass Association of North America (GANA) - "Glazing Manual", and "Sealant Manual".
- D. Insulating Glass Manufacturers Alliance (IGMA) - SIGMA TM-3000: Glazing Guidelines for Sealed Insulating Glass Units.

1.3 SUBMITTALS

- A. Product Data: Submit product data indicating structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
- B. Samples: Submit two samples, 6 x 6 inches in size, illustrating each type of glazing unit.

- C. Certification: Submit certification that glazing materials used on the Project conform to all applicable requirements of CSPE "Safety Standard for Architectural Glazing Materials", and the requirements of the California Building Code.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with 2010 California Building Code (CBC), Chapter 24, "Glass and Glazing."
 - 2. Safety Glazing: Comply with ANSI Z97.1 and testing requirements of Consumer Products Safety Commission (CPSC) "Safety Standard for Architectural Glazing Materials, 16 CFR Part 1201, Category II".
 - a. Tempered Glass: Identify type and thickness, permanently etched in the glass surface and located on a corner so as to be visible after the glass is installed.
- B. Glazing Standards: Comply with recommendations of the following, except where more stringent requirements are indicated:
 - 1. Glass Association of North America (GANA) "Glazing Manual" and "Sealant Manual" for glazing installation methods.
 - 2. Sealed Insulating Glass Manufacturers Association (SIGMA) TM-3000 "Vertical Glazing Guidelines".
- C. Insulating Glass Certification Program: Provide insulating glass units permanently marked with appropriate Insulating Glass Certification Council (IGCC) certification label.

PART 2 PRODUCTS

2.1 GLASS MATERIALS

- A. Clear Float Glass: ASTM C 1036, Type I - Transparent, Class 1 - Clear, Quality q3 - Glazing select, 1/4-inch thick, unless otherwise noted; Guardian Industries, Fresno, California, or equal.
- B. Clear Tempered Float Glass: ASTM C1036-85, Type I, Class 1, Quality q3; tempered where shown and required in accordance with ASTM C1048, Kind FT - Fully Tempered, Condition A - Uncoated surfaces; 1/4-inch thick. Provide where required for safety glazing.
- C. Insulating Glass: 1-inch thick sealed insulating glass units, tempered where required.
 - 1. Standard: Comply with ASTM E 774, Class A, and Insulating Glass Manufacturers Alliance Document SIGMA TM-3000.

2. Manufacturer/Type: Guardian Industries, Fresno, California "SunGuard SuperNeutral SN68 CrystalGray", Viracon "Solarscreen 2000 Low-E Insulating Glass", or PPG.
3. Outer Lite: 1/4-inch thick clear glass, low-e coating on #2 face: Guardian VE 1-2M #2.
4. 1/2-inch air space, consisting of the following:
 - a. Sealing System: Dual seal with polyisobutylene primary seal and silicone secondary seal, black color.
 - b. Spacer material: Manufacturer's standard metal, black color.
 - c. Dessicant: Manufacturer's standard; either molecular sieve or silica gel, or a blend of both.
5. Inner Lite: 1/4-inch thick clear float glass.
6. Solar Heat Gain Coefficient: 0.30.
7. Visible Light Transmittance: 49 percent.

2.2 GLAZING ACCESSORIES

- A. Elastomeric Glazing Sealant for Nonporous Substrates: Silicone type, meeting ASTM C 920, Type S, Grade NS, Class 25, medium modulus, neutral cure; color to be selected by Architect; Dow Corning "795", G.E. "Silglaze II SCS2800 Sealant", or equal.
- B. Setting Blocks: Closed cell preformed silicone or neoprene rubber, complying with ASTM C 509; 80-90 Shore "A" durometer hardness; size as required to set glass properly. Where glazing block is in contact with silicone sealant, provide silicone glazing block compatible with the silicone sealant.
- C. Spacer Shims: Silicone or neoprene elastomeric blocks or continuous extrusions; 50-80 Shore "A" durometer hardness; size as required to set glass properly.
- D. Glazing Tape: Preformed butyl-polyisobutylene compound 10-15 Shore A durometer hardness; coiled on release paper; size as required to set glass properly; black color; Presstite, Hapco, or equal.
- E. Glazing Clips: Manufacturer's standard type.
- F. Mirror Adhesive: Palmer Products Corporation "Mirro-Mastic", Gunther, or equal, non-harmful mastic specifically designed for installing mirrors without mechanical fasteners.

2.3 FABRICATION

- A. Glazing channel dimensions as shown are intended to provide for necessary minimum bite on the glass, minimum edge clearance, and adequate sealant thickness, with reasonable tolerances. Correctly size the glass for each opening, within the tolerances and necessary dimensions established.

- B. Factory-label each pane of glass; do not remove labels until final acceptance is obtained.
- C. Tong marks on tempered glass shall not be permitted; use horizontal tempering process.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with combined recommendations of glass manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are shown or specified.
- B. Install setting blocks of proper size in sill rabbet; locate at one-fourth of glass width, measured from each jamb.
- C. Provide spacers inside and out and of proper size and spacing for glass sizes larger than 50 united inches, except where preshimmed tape or gaskets are used for glazing. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width, except with butyl-rubber sealant tape, use thickness 1/32-inch less than final compressed thickness of tape.
- D. Prevent exudation of sealant or compound by forming voids or installing filler rods in channels at heel of jambs and heads (do not leave voids in sill channels), except as otherwise indicated.
- E. Force sealants into channel to eliminate voids and to ensure complete "setting" or bond of sealant to glass and channel surfaces.
- F. Tool exposed surfaces of sealant to provide a substantial "wash" away from the glass. Where pressurized tape is used for exterior glazing, provide silicone cap bead sealant; no portion of tape shall be exposed to weather.
- G. Clean and trim excess glazing materials from the glass and stops of frames promptly after installation and eliminate stains and discolorations.

END OF SECTION

SECTION 09960 – PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The scope of work includes wash down, surface preparation, coating application, touch-up, protection of uncoated surfaces, containment of airborne debris, waste disposal, cleanup and all appurtenant work. The specified coating systems shall be applied only to the surfaces and miscellaneous pipes as described in this Section.
- B. These surfaces include, but are not limited to the Headworks, Equalization Basin No. 1 and No. 2, Primary Clarifier, and Trickling Filters. Contractor shall also repair all existing coatings at the project site that are damaged as a result of the Work performed within the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01300 (Submittal Process)

1.3 REFERENCED STANDARDS, CODES, AND REGULATIONS

- A. ASTM: American Society for Testing and Materials, International
 - 1. D4262: Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
 - 2. D4263: Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
 - 3. D4414: Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gauges
 - 4. D5402: Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
 - 5. D7091: Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
- B. CCR: California Code of Regulations Title 8, Industrial Relations
 - 1. Section 1670: Personal Fall Arrest Systems, Personal Fall Restraint Systems and Positioning Devices
 - 2. Section 5157: Permit Required Confined Spaces
 - 3. Section 1532.1: Containment, Disposal, and Safety Requirements for Lead
- C. SSPC Steel Structures Painting Council, the Society for Protective Coatings
 - 1. PA 1 Shop, Field, and Maintenance Painting of Steel

2. PA 2 Measurement of Dry Film Thickness with Magnetic Gauges
3. QP 1 Qualification Procedure 1 for Field Coating
4. QP 3 Qualification Procedure 3 for Shop Painting
5. SP1 Solvent Cleaning
6. SP2 Hand Tool Cleaning
7. SP3 Power Tool Cleaning
8. SP7 Brush Off Blast Cleaning
9. SP10 Near White Blast Cleaning
10. SP11 Power Tool Cleaning to Bare Metal
11. SP 13 Surface Preparation of Concrete
12. VIS 3 Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning
13. Vol. 1 Good Painting Practice

D. NSF National Sanitation Foundation

1. NSF 61 Drinking Water System Components

1.4 SUBMITTALS

A. The Contractor shall submit the following in accordance with the requirements in Section 01300, Submittals. The Contractor shall submit the following prior to mobilizing to the project site:

1. The Contractor shall provide SSPC QP 1 Certification.
2. Qualifications of the Field Applicator: Copy of an active State of California C 33 Contractor's license as required for the application of coatings.
3. Provide 3 references which show that the Contractor has previous successful experience with each specified or comparable coating systems in the past 5 years. Include the name, address, and the telephone number for the owner of each installation for which the Contractor applied the protective coating.
4. Provide a written letter from the Contractor stating that they are certified by the manufacturer and experienced in the application of the specified coating systems in the past 5 years. The letter shall state the manufacturer and model number of mixing, heating, and pumping equipment to be used to apply the specified coating system.

B. Complete data on each type of coating, primer, caulking, adhesive, and materials shall be

submitted for review. Acceptance shall be received from the District before the materials are delivered to the jobsite. This procedure shall be followed whether or not the material that the Contractor proposes to use is named in the Contract Documents. Submitted data shall show where and for what uses each paint product is proposed with cross-reference made to sections of these Specifications. Paint material submittals shall include the following:

1. Material safety data sheets for all products used at the jobsite including paints, thinners, solvents and cleaners.
 2. Product Data Sheets for all primers, concrete surface fillers, caulking, adhesives, and coating products with the following information:
 - a. Surface preparation requirements for immersion service
 - b. Minimum and maximum wet and dry film thickness per coat
 - c. Minimum and maximum cure, induction, and pot life times
 - d. Temperature and humidity requirements during and after application
 - e. Proper storage and shelf life at various temperatures
 - f. EPA Method 24 results to verify compliance with BAAQMD Rule 8-3 for VOC's
 - g. Tensile, elongation, moisture vapor transmission rate, and abrasion testing results.
- C. Manufacturer's product data sheet for each abrasive material to be used with the following:
1. Technical data sheet for each product used, including statements on the suitability of the material for the intended use.
 2. State and country of origin.
 3. Material safety data sheet for each product, if applicable.
 4. Size/mesh and percentage by weight of each component
- D. Samples: During the coating application, the Contractor shall submit three coating samples of the 100% solids coating on 6-inch by 6-inch sheet concrete mortar samples. Each sample shall be abrasive blasted and completely coated over its entire surface with the complete coating system including primers.
- E. Coating Manufacturer's Information: For each coating system to be used, the Contractor shall submit the following listed data at least 14 days prior to application:
1. Coating manufacturer's technical application instructions for application, heating materials, mixing, spray tip sizes, and hose pressures.
 2. The manufacturer shall provide written certification that the coating Contractor's supervisor and each applicator performing Work on the project have been trained and approved by the manufacturer to apply the selected coating system. The

manufacturer shall state whether or not it has verified that the Contractor is going to use the proper mixing, coating application, heating, and environmental control equipment for the specified coating products.

1.5 QUALITY ASSURANCE

A. Pre-construction meeting: The Contractor's project manager shall attend a pre-construction meeting at least three weeks before start of application of the coating systems. It shall also be attended by the Owner, Coating Inspector, and Contractor's health and safety officer. The meeting shall include a discussion on the following:

1. Health and safety
2. Shutdown plan and schedule
3. Environmental controls and containment requirements
4. Protection of surfaces not scheduled to be coated
5. Staging of equipment
6. Field quality control
7. Cleaning
8. Contractor/Inspector/Owner Relationship
9. Communication protocol
10. Coordination with regular maintenance work or other projects
11. Dust control

B. The Contractor shall provide satisfactory documentation from the manufacturer of the proposed substitute material that said material meets the requirements and is equivalent to or better than the listed materials in the following properties:

1. NSF Standard 61 or UL Water approval
2. Minimum and maximum recoat times with itself and with topcoats
3. Minimum and maximum cure times for immersion
4. Abrasion Resistance per ASTM D4060 using a CS17 Wheel
5. BAAQMD Rule 8-3 VOC compliance
6. Dry film thickness per coat
7. Compatibility with other coatings
8. Suitability for the intended service on steel or concrete

9. Resistance to chemical attack
10. Temperature limitations in service and during application
11. Type and quality of recommended undercoats and topcoats
12. Ease of application
13. Ease of repairing damaged areas
14. Stability of colors
15. Minimum adhesion of 100% solids epoxy shall be 1,000 P.S.I. as per ASTM D-4541 using a Type II instrument.
16. 100% solids polyurethane return to service time shall be less than 56 hours @ 77 degrees

1.6 HEALTH AND SAFETY

- A. In accordance with the requirements of CCR Title 8 Section 5157, the Contractor shall provide and require the use of personal protective and lifesaving equipment for all persons working in confined spaces.
- B. Head and face protection and respiratory devices shall include protective helmets conforming to the requirements of ANSI Z 89.1-2009 which shall be worn by all persons at all times while in the vicinity of the work when coatings are being applied. In addition, workers engaged in or near the work during sandblasting shall wear eye and face protection devices meeting the requirements of ANSI Z 87.1-2010 and a respirator with appropriate filter.
- C. Where ventilation is used to control potential exposures to workers, as set forth in Section 1910.94 of the OSHA Regulations for Construction, ventilation shall be adequate to reduce the concentration of the air contaminant to the degree that a hazard to the worker does not exist. Methods of ventilation shall meet the requirements set forth in ANSI Z9.2-2006.
- D. Temporary ladders and scaffolding shall conform to the applicable requirements of CCR Title 8 Section 1676 and Section 1670. The Contractor shall submit scaffolding plans to the District for review.

1.7 INSPECTION AND TESTING COORDINATION

- A. The Contractor shall give the District's Coatings Inspector a minimum of 2 days of advance notice of the start of any field surface preparation work for coating application work.
- B. All such work shall be performed only in the presence of the Inspector, unless Inspector has granted prior approval in writing to perform such work in his/her absence.
- C. Inspection by the Inspector, or the waiver of inspection of any particular portion of the work, shall not relieve the Contractor of its responsibility to perform the work in accordance with these Specifications.

- D. The Contractor shall hold all surface preparation and coating application operations until Inspector approves the following inspection points: concrete surface preparation mock up sample area following completion of blasting; completion of concrete resurfacing; primer application; coating application and testing of cured coating.
- E. Scaffolding shall be erected and moved to locations where requested by Inspector to facilitate inspection. Additional illumination shall be provided to cover all areas to be inspected.

1.8 RECORDS

- A. The Contractor shall maintain an accurate, written record of the quantity of coating material applied and the corresponding surface area covered, a description of the area coated, the batch number, surface temperature, ambient temperature, relative humidity, dewpoint, and applicator on a daily basis. The Contractor shall furnish a signed copy of said record to the Inspector at the beginning of the next working day. These quantities shall be independently verified by the Inspector and reported on the Inspector's log. The Inspector shall immediately investigate and resolve any discrepancies between these reported quantities.

1.9 MANUFACTURER'S PARTICIPATION

- A. The Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support and as necessary to resolve field problems attributable to or associated with the manufacturer's products furnished under this Contract or the application thereof. The manufacturer's representative shall be onsite at the end of the surface preparation, during mixing and the start of the application, and during any relining work as required by the District, at no additional cost to the District.

1.10 WARRANTY

- A. The Contractor and coating manufacturers shall warrant the coating system applications against defects and workmanship after final acceptance of the Work for a period of 1 year. The Contractor shall perform all Work and supply all equipment and materials associated with the repair of failures identified in the warranty inspection at no cost to the District.
- B. The material manufacturer shall warrant for a period of 1 year that its products meet published physical properties and that they are free of manufacturing defects.
- C. The material manufacturer shall replace any defective product and the Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during the warranty period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the District.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Definitions: The term "paint", "coatings", or "finishes" as used herein, shall include surface treatments, powders, enamels, paints, epoxy resins, and all other protective coatings,

excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat. The term "DFT" means minimum dry film thickness.

- B. General: Coating materials shall be sealed in new containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer, all of which shall be plainly legible at the time of use.
- C. The CONTRACTOR shall use coating materials suitable for the intended use and recommended by their manufacturer for the intended service.
- D. Compatibility: In any coating system, only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats.
- E. Colors: All colors and shades of colors of all coats of paint shall be as selected or specified by the DISTRICT.
- F. Protective Coating Materials: Products shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the CONTRACTOR shall provide the DISTRICT with the names of not less than 5 successful applications of the proposed manufacturer's products demonstrating compliance with this specification requirement.
- G. Substitute or "Or-Equal" Submittals: Coating materials suitable for immersion and non-immersion and recommended by their manufacturer for wastewater fluids, liquid, and gases shall be applied. Unless otherwise specified, materials are from the catalogs of the companies listed herein. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed and accepted by the ENGINEER. The CONTRACTOR shall provide satisfactory documentation from the firm manufacturing the proposed substitute or "or-equal" material that said material meets the specified requirements and is equivalent to or better than the listed materials in the following properties:
 - 1. Minimum and Maximum Cure Times
 - 2. Moisture Vapor Transmission Rate per ASTM D1653 Method B at 60 mils minimum
 - 3. Abrasion Resistance per ASTM D4060 using a CS17 Wheel
 - 4. Minimum and Maximum Recoat Times
 - 5. Solids content by volume
 - 6. Dry film thickness per coat
 - 7. Compatibility with other coatings
 - 8. Suitability for wastewater solids, liquids, and gases
 - 9. Resistance to chemical attack

10. Temperature limitations in service and during application

- H. The cost of all testing and analysis of the proposed substitute materials that may be required by the DISTRICT shall be paid by the CONTRACTOR. If the proposed substitution requires changes in the Contract work, the CONTRACTOR shall bear all such costs involved and the costs of allied trades affected by the substitution.

2.2 COATING SYSTEMS

- A. Material Sources: Each of the following manufacturers is capable of supplying many of the industrial coating materials specified herein. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials shall be shown to satisfy the material descriptions and to equal or exceed the properties of the listed materials as required in the paragraph entitled "Substitute or 'Or-Equal' Submittals" herein.

1. Raven Lining Systems

2. Sauereisen

3. Sprayroq

1. ACYL – Single component, water based acrylic latex with a fungicide additive shall have a minimum solids content of 35% by volume. Prime coat shall be as recommended by manufacturer. The coating material shall be available in the ANSI safety colors.

1. Prime coat (DFT = 2 mils), as recommended by manufacturer for substrate.

2. Finish coats (DFT = 6 mils), Amercoat 220, Sherwin Williams Pro Industrial Acrylic, or equal.

3. Total system DFT = 8 mils.

- B. ACY – High molecular weight acrylic coating material shall have a minimum solids content of 35% by volume. Prime coat shall be an acrylic filler and sealer for concrete surfaces.

1. Prime coat (Filler/sealer), Tnemec Series 130 Envirofill, Sanitile 100, or equal.

2. Finish coats (2 or more, DFT = 3 mils), Tnemec Series 6 Tnome-Cryl, Carboline 3359 Flat, or equal.

- C. BIT – Bituminous: To be used for the isolation of ferrous and non-ferrous metals from concrete and for the exterior of buried piping that is not coated with petrolatum tape or polyethylene encasement. Approved Products include the following:

1. Finish Coat (1 coat at 20 mils DFT), Tnemec 46-465, Bitumastic 300, Christy's HD50, or equal (8 mils).

- D. CML – Cement Mortar Coating: A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than 1 part Type II cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane-Forming

Compounds for Curing Concrete" ASTM C 309-81, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped by at least 6 inches.

- E. CTE - Coal Tar Epoxy: High build, two-component amine cured coal tar epoxy shall have a solids content of at least 68% by volume, suitable for long term immersion in wastewater and for coating of buried surfaces, and conforming to DOD P 23236, Class 2, or to SSPC Paint 16. Prime coats are for use as a shop primer only. Prime coat shall be omitted when both surface preparation and coating are to be performed in the field.
 - 1. Finish coats (2 or more, DFT = 16 mils), Amercoat 78 HB, International Paint Devtar 5A-HS, or equal.
 - 2. Total system DFT = 16 mils.
- F. DIP1 – Ceramic Epoxy shall be used to line the interior surfaces of ductile iron pipe exposed to high solids sludge. Ceramic Epoxy lining shall be used for all solids processing piping 10 inches diameter and larger. Approved Products include the following:
 - 1. Finish coat (1 coat at 30 mils DFT), Protecto 401 as manufactured by Induron Coatings, Inc.
- G. DIP2 - Novalac Epoxy shall be used to line the interior surfaces of ductile iron pipe exposed to municipal sludge. Approved products include the following:
 - 1. Finish coat (1 coat at 40 mils DFT), SP2000W as manufactured by Superior Environmental Products.
- H. DIP3 – Glass Lining: To be used to line the interior surfaces of steel or ductile iron pipe exposed to solids processing piping. Approved products include the following:
 - 1. Finish coat (10 mils DFT), SG-14, as manufactured by VITCO, MEH-32 as manufactured by Ferroch, or equal.
- I. EAP – Epoxy and Aliphatic Polyurethane. Primer shall be a rust inhibitive two-component epoxy coating with a minimum solids content of 70% by volume. Two-component aliphatic acrylic or polyester polyurethane coating material shall provide superior color and gloss retention under UV exposure, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering and with a minimum solids content of 58% by volume.
 - 1. Prime coat (DFT = 4 mils), Amerlock 2, Carboguard 890, Sherwin Williams Macropoxy 646, or equal.
 - 2. Finish coat (one or more, DFT = 3 mils), Amershield VOC, Carbothane 133 VOC, Sherwin Williams Hi Solids Polyurethane 250, or equal.
 - 3. Total system DFT = 7 mils.
- J. EF – Epoxy Filler, Concrete with Surface Voids: High build epoxy filler compound, shall have a solids content of 100% by volume, suitable for long term immersion in water and for coating of buried surfaces and conforming to DOD P 23236, Class 2, or to SSPC Paint 16.

Filler-surfacer compound shall be a two-component epoxy material used to fill concrete bugholes, honeycomb, thin cracks, voids and rough areas greater than 1/8 of an inch in depth or 1/4 of an inch in width. The seal coat provides a smooth surface for the application of the coal tar epoxy. The seal coat is a two-component epoxy material with 100% solids and is applied to the entire concrete surface and worked into the concrete surface with a wide blade putty knife or a squeegee.

1. As required to provide an even surface prior to primer and finish coating, Nu-Klad 114A, Tnemec Series 218 Mortarclad, or equal.
- K. EFEP - Epoxy Filler/Epoxy Phenolic, Concrete with Surface Voids: Epoxy-phenolic amine cured resin with a solids content of at least 55% by volume, and suitable for long-term immersion in water and exposure to the effects of hydrogen sulfide gas where there is the probability of sulfuric acid formation on the surfaces. The filler-sealer shall be a 100% solids amine cured epoxy material with silica and inert fillers. A 100% solids epoxy surfacer shall be used to fill holes and patch the concrete surfaces after abrasive blasting.
1. Prime coat (filler-sealer), applied in two coats to the entire surface using a squeegee to achieve a smooth, void-free surface, Plasite 9029, Amerlock Sealer followed by Nu-Klad 114A, Tnemec Series 218, or equal.
 2. Finish coats (Two or more coats, DFT = 12 mils), Plasite 7122, Amercoat 90HS, Tnemec 435 at 12 to 20 mils DFT, or equal. On stairways and in walking and working areas use Plasite 7122 HAR, or use Amercoat 346 with Amercoat 886 non-skid additive in the final coat.
 3. Two or more coats, DFT = 125+ mils, Plasite 7122, Amercoat 90HS, Tnemec 434 at 125 mils DFT topcoated with Tnemec 435 at 12 to 20 mils DFT, or equal
- L. EP – Epoxy Phenolic: Epoxy-phenolic amine cured resin with a solids content of at least 55% by volume, and suitable for long-term immersion in water and exposure to the effects of hydrogen sulfide gas where there is the probability of sulfuric acid formation on the surfaces.
1. Prime coat and finish coats (3 or more, DFT = 12 mils), Plasite 7122, Amercoat 90HS, Tnemec 435, or equal.
- M. ENS – Epoxy Non-Skid Floor Coating: Epoxy primer, two-component epoxy non-skid and aliphatic polyurethane floor surfacing shall be formulated to resist and sunlight without staining. Products shall be as follows, or equal:
1. Prime Coat (1 coat at 6 to 8 mils), Amercoat 235 Multi-Purpose Epoxy Coating
 2. Finish Coat (1 coat at 5 to 10 mils), Amercoat 237M Heavy Duty Epoxy Non-Skid Coating
 3. Total system DFT = 11 to 18 mils
- N. E1 – Amine cured Epoxy, Indoor and Immersion Exposure: High-Build, amine cured, straight epoxy resin shall have a solids content of at least 70% by volume, and be suitable for long-term wastewater exposure. The following products are approved:

1. Prime Coat (DFT = 5 to 6 mils), Carboline Carboguard 890, PPG Amercoat Amerlock 2 VOC, Sherwin Williams Macropoxy 646, or equal
 2. Total System DFT: 5 to 6 mils
- O. E2 – Amine Cured Epoxy, Indoor and Immersion Exposure: High-build, amine cured, straight epoxy resin shall have a solids content of at least 70% by volume, and shall be suitable for long-term wastewater exposure. The following products are approved:
1. Intermediate Coat (DFT = 5 to 6 mils), Carboline Carboguard 890, PPG Amercoat Amerlock 2 VOC, Sherwin Williams Macropoxy 646, or equal
 2. Final Coat (DFT = 5 to 6 mils), PPG Amercoat Amerlock 2 VOC, Sherwin Williams Macropoxy 646, or equal
 3. Total System DFT: 10 to 12 mils
- P. E100 – 100% Solids Epoxy: To be used to line the interior surfaces of steel pipe or concrete exposed to municipal potable water. It shall be NSF Standard 61 approved for potable water exposure. Approved products include the following:
1. Raven Lining Systems Raven 405, International Paint Enviroline 230 as manufactured by International Paint.
 2. New Concrete Finish coat: 60 mils DFT
 3. Existing Concrete Finish coat: 125 mils DFT
- Q. FBE – Fusion Bonded Epoxy: The coating material shall be a 100% powder epoxy applied in accordance with the AWWA C213 "AWWA Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines", except that the surface preparation shall be as specified in the coating system schedule of this section. The coating shall be applied using the fluidized bed process for steel less than 24 inches in height. Electrostatic FBE will require prior approval by the Owner.
1. Liquid Epoxy: For field repairs or where, as confirmed by the Inspector, it would be impossible to use the powder epoxy method without causing damage to the item, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT of 15 mils. The liquid epoxy shall be a 100% solids epoxy recommended by the powder epoxy manufacturer.
 2. Coating (DFT = 16 mils), Scotchkote 206N, or equal.
 3. Total system DFT = 16 mils.
- R. JTS – Joint Sealant – Joint sealant shall be installed over expansion joints greater than ¼-inch in width. Approved products include the following:
1. Prime Coat (DFT = as recommended by manufacturer), Sika Sikaflex Primer 429, Masterseal P173 primer, or equal
 2. Finish coat (DFT = as needed), Sika Sikaflex 2c NS, BASF Masterseal NP-2, or

equal

- S. IZEP – Inorganic Zinc/Epoxy/Polyurethane: The inorganic zinc primer shall be a water or solvent based, self-curing, zinc silicate two-component inorganic coating which contains at least 80% of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. The intermediate coat shall be a high-build two component epoxy with a solids content of at least 70% by volume. If the steel surface is UV-exposed, finish coats shall be a two-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58% by volume.
1. Prime coat (DFT = 2 mil), Dimecote 9 VOC, Tnemec 90-97 Tneme-Zinc, Carbozinc 11 VOC or equal.
 2. Intermediate coat (DFT = 4 mils), Amerlock 2, Carboline 890, Tnemec 104, or equal.
 3. If the surface is UV-exposed, finish coats (one or more, DFT = 3 mils), Amershield VOC, Carboline 133VOC, Tnemec Series 1075 Endura-Shield, or equal.
 4. Total system DFT = 9 mils.
- PE – Polyethylene Encasement for Ductile Iron Pipe: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.
- T. PT – Petrolatum Tape: Prior to wrapping the pipe with petrolatum tape, the pipe and fittings first shall be primed using a primer recommended by the petrolatum tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive petrolatum tape, half-lapped, to a total thickness of 40 mils. All wrapped coating shall be spark-tested per NACE SP0188 in the Presence of the Inspector. Approved products include the following:
1. Primer (DFT = 1 gal/100 sq. ft), Wax Tape Primer as manufactured by Trenton Corporation.
 2. Profiling Mastic (DFT as needed to provide smooth profile for the coating system), Fill-Pro PM-GP as manufactured by Trenton Corporation.
 3. Tape (DFT = 70 mils), #1 Wax Tape as manufactured by Trenton Corporation.
 4. Mechanical Protection Outer Wrap (DFT = 1.5 mils), Poly-Ply as manufactured by Trenton Corporation.
- U. PVC – Concrete Embedded PVC Liner: To be used to line cast-in-place or prefabricated concrete exposed to municipal wastewater. Approved products include
1. T-Lock as manufactured by Ameron International Protective Lining Products or approved equal.
 2. Thickness Required: 60 mils.
- V. P100 – 100% Solids Polyurethane – To be used to line the interior surfaces of steel pipe or concrete exposed to municipal wastewater, gas, and sludge. Approved products include

Endura Flex 1988 as manufactured by Global Eco Technologies, Polibrid 705 as manufactured by Carboline Company.

1. New Concrete Finish coat: 60 mils DFT.
 2. Existing Concrete Finish Coat: 125 mils DFT
- W. RMTR – Resurfacer for concrete walls or structures following the abrasive blasting shall be high early strength, epoxy-modified mortar with aggregates capable of producing a dry rough finished surface. The material shall be a two or three-component aggregate-filled mortar to be applied on vertical walls and overhead walls and capable of being topcoated within 24 hours of application. Approved products include the following:
1. Finish Coat (Thickness = Less than ½-inch or greater to produce an even surface), Sauereisen Restokrete Filler Compound 209, Tnemec Series 218 Mortar Clad, or approved equal.
 2. Total Thickness = ½-inch or greater as needed to produce an even surface.
- X. SIL1000 - Aluminum Silicone Resin and Zinc-Rich Primer: Aluminum silicone resin material shall be suitable for a service temperature of up to 1,000°F, and shall comply with Federal Specification TT-P-28. Zinc rich primer shall only be applied on non-immersion steel surfaces that are above or exposed to the wastewater surface.
1. Prime coat (DFT = 1.5 to 2 mils) – Thurmalox 245C, Thermaline 2977, or equal
 2. Finish coat (2 coats, DFT = 1.5 to 2 mils per coat) – Thurmalox 230C, Thermaline 4700 VOC, or equal.
 3. Total system DFT = 4.5 to 6 mils.
- Y. VAL1 – Powder coating for steel, cast iron, and ductile iron valves to be shop coated and lined. The powder coating shall be polyester or acrylic-based and shall resist a minimum of 1,000 hours of salt fog testing per ASTM B117 with blistering or rusting. Approved products include the following:
1. Finish Coat (DFT = 3 to 6 mils), Tiger Drylac Series 49, Bray Controls Nylon 11, or equal.
- Z. VE1 – Epoxy/Vinyl Ester Reinforced Flexible Lining-Concrete: A 100% solids vinyl ester primer, 100% solids epoxy silica reinforced basecoat, fiberglass mat reinforcement intermediate layer, and an epoxy or vinyl ester topcoat. The vinyl ester topcoat shall be used for ferric chloride, sodium hypochlorite, or citric acid exposure and the epoxy topcoat shall be used for the sodium bisulfate exposure. The entire system shall be suitable for immersion service in citric acid, sodium bisulfate and sodium hypochlorite solutions in secondary containment areas.
1. Prime coat (DFT=3 to 4 mils): Primer 67 as manufactured by Dudick Inc. or approved equal.

2. Base coat with silica filler (DFT=25 sq. ft. per gallon): Protecto-Flex 800, Protecto-Flex 805, or Protecto-Flex 310 Basecoat as manufactured by Dudick Inc. or approved equal.
 3. Intermediate Reinforcing Mat: 1 ounce chopped fiberglass strand mat
 4. Intermediate Saturant Coat (DFT=60 sq. ft. per gallon): Protecto Flex 800, Protecto-Flex 805, or Protecto-Flex 310 Basecoat as manufactured by Dudick Inc. or approved equal.
 5. Topcoat (DFT=60 to 70 sq. ft. per gallon): Protecto Flex 800 Topcoat, Protecto Flex 805 or Protecto-Flex 310 Topcoat as manufactured by Dudick Inc. or approved equal.
 6. Total System DFT: 100 to 110 mils
- AA. VE2 – Vinyl Ester or Epoxy Reinforced Lining-Concrete: A 100% solids vinyl ester or epoxy primer, 100% solids vinyl ester or epoxy graphite-reinforced basecoat, fiberglass mat reinforcement intermediate layer, aluminum oxide filled vinyl ester or epoxy topcoat, and aliphatic polyurethane finish coat. The vinyl ester basecoat/topcoat shall be used for sodium hypochlorite or citric acid exposure and the epoxy basecoat topcoat shall be used for the sodium bisulfate exposure. The entire system shall be suitable for accidental splashing or spilling of citric acid, sodium bisulfate and sodium hypochlorite solutions in chemical storage unloading areas with truck traffic and sun exposure.
1. Prime coat (DFT=3 to 4 mils): Primer 27 as manufactured by Dudick Inc. or approved equal.
 2. Base coat with graphite filler (DFT=25 sq. ft. per gallon): Protecto-Line 100, Protecto-Line 800, or Protecto-Line 805 with G-9 filler as manufactured by Dudick Inc. or approved equal.
 3. Intermediate Reinforcing Mat: 1 ounce chopped fiberglass strand mat
 4. Intermediate Saturant Coat (DFT=60 sq. ft. per gallon): Protecto Line 800, Protecto-Line 805, or Protecto-Line 100 Basecoat as manufactured by Dudick Inc. or approved equal
 5. Topcoat (DFT=60 to 70 sq. ft. per gallon): Protecto-Line 800, Protecto-Line 805 with G-9, Protecto-Line 100 with G-9 as manufactured by Dudick Inc. or approved equal.
 6. Finish coat (DFT=5 mils): Sealer 30 as manufactured by Dudick Inc. or approved equal.
 7. Total System DFT: 125 mils

PART 3 - EXECUTION

3.1 ENVIRONMENTAL CONDITIONS

- A. No coating work shall be performed under the following conditions:
1. Surface or ambient temperatures exceed the manufacturer's recommended maximum or minimum allowable.
 2. Dust or smoke laden atmosphere.
 3. Damp or humid conditions, where the relative humidity is above the manufacturer's maximum allowable.
 4. Substrate and ambient temperatures are less than 5°F above the dewpoint and are decreasing. Dewpoint shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.
 5. Ambient temperature that is expected to drop below 50°F or less than 5°F above the dewpoint within 8 hours after application of coating.
- B. If the WORK on the structure is subject to extended periods of low temperature or high humidity, the Contractor shall be expected to maintain the established production schedule despite these potentially adverse conditions by providing all labor, equipment and materials necessary to maintain a controlled environment in the area where WORK is to be performed. The substrate and atmospheric conditions within the controlled environment, with respect to temperature and relative humidity, shall be maintained within the limits established by the manufacturer of the selected coating system to ensure proper application and cure of the coating. If the conditions are not in the specified ranges stated by the manufacturer, the Contractor shall use the following:
1. Humidity Control – Desiccant or Direct Expansion Refrigeration dehumidification will be used to control the environment in the space 24 hours a day during blast cleaning, coating application and coating cure. Equipment will conform to the following requirements:
 - a. Equipment – Desiccant dehumidifiers will be a solid desiccant design having a single rotary desiccant wheel capable of fully automatic continuous operation. No liquid, granular, or loose lithium chloride drying systems will be accepted. The use of direct expansion (DX) refrigeration type dehumidifiers with reheat may be considered if the expected ambient temperature will remain above 60°F. Heating the space changes relative humidity only and does not change the dew point temperature. Heat alone, therefore, is not a substitute for dehumidification, unless substrate temperature is high enough to meet the dew point differential. The dehumidification system may consist of a combination of desiccant and refrigerant equipment.
 - b. Air Changes – The air change rate for maintaining the required spread of 17°F between inside surface temperature and inside space dew point temperature with a maximum relative humidity of 45% in the space will depend upon the type of equipment to be used and the time of year during the application. There shall be 1 to 3 air changes per hour, depending on the air volume of the structure, to hold the desired degree of cleanliness of the surface.
 2. Temperature Control – Auxiliary cooling or insulation may be necessary to maintain the surface temperature at an acceptable level for the coating manufacturer's

application parameters. This auxiliary equipment must be approved for use by the supplier of the dehumidification equipment and will meet the following requirements.

- a. Refrigerant type systems must be installed in the process air supply duct between, and/or blended with, the dehumidifier as close to the work space as possible.
- b. Only electric, indirect fired combustion, or steam coil auxiliary heaters will be used. No direct-fired space heaters will be allowed during the blasting, coating, or curing phases.
- c. The space to be controlled will be sealed off as well as possible, allowing air to escape the work space away from the point where the dehumidified air is being introduced. If it is necessary to filter the air escaping the space, the filtration system must be designed so that it does not interfere with the dehumidification equipment's ability to control the dew point and relative humidity of the work space.

3.2 SURFACE PREPARATION OF METALLIC SURFACES

- A. The minimum surface preparation shall be as specified in the coating system schedules included at the end of this Section.
- B. The Shop Applicator shall remove all water, grease, dust, and other contaminants from the surfaces prior to centrifugal or manual abrasive blast cleaning. All oil, grease, welding fluxes and other surface contaminants shall be removed by solvent cleaning per SSPC SP1 prior to blast cleaning.
- C. All sharp edges and welds shall be rounded or chamfered and all burrs, surface defects, and weld spatter shall be ground smooth prior to abrasive blast cleaning. The power tool cleaning shall conform to SSPC SP3 and NACE RP0178.
- D. Abrasive Blast Cleaning – The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.
- E. The Field Applicator shall not reuse abrasive blasting media unless otherwise approved by the INSPECTOR.
- F. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil/moisture separators which remove at least 95% of the contaminants. If necessary, the INSPECTOR shall conduct oil and water tests per ASTM D4285.
- G. For every 100 square feet of steel that is blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the INSPECTOR. For every 100 square feet of steel pipe blasted, the surface profile shall be tested at locations determined by the INSPECTOR. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test

shall be performed within a single test area 12 inches in diameter. For each test area, the replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile.

- H. Metal surfaces less than 25 square feet which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP1, SP2, and SP11. Damaged shop coating shall be cleaned in accordance with SSPC SP11 using an MBX Bristleblaster, or equivalent, and recoated with the primer specified.
- I. The Field Coating Applicator shall not apply a coating on a bare steel surface that is to be immersed and has not been prepared to an SSPC SP10 surface profile. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.
- J. The CONTRACTOR shall verify the wet film thickness with a notched gauge in conformance with ASTM D4414. Wet film thickness readings shall be recorded a minimum of every 100 square feet.
- K. Surfaces shall be cleaned of all dust and residual particles by dry air blast cleaning, vacuuming, or other approved methods, prior to coating.
- L. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth to prevent contamination of previously cleaned surfaces.
- M. The Field Applicator shall not apply a coating on a bare steel surface for non-immersion service that has not been prepared to per SSPC SP6. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

3.3 SURFACE PREPARATION CONCRETE

- A. All loose, brown, white, carbonated, deteriorated, or unsound concrete shall be removed in the immediate vicinity of the documented damaged areas to provide a termination point that is tightly adhered to the concrete surfaces. The CONTRACTOR shall use high pressure water jetting per SSPC WJ-4 at a minimum pressure of 5,000 psi.
- B. Concrete surfaces shall be abrasive blasted per SSPC SP13 to remove the top 0.125 inches of brown, white, loose concrete and to produce a surface roughness equivalent to that of ICRI 310.2 Concrete Surface Profile 5. The depth of concrete to be removed shall be measured by pre-drilling holes 0.125 inch deep, 5 feet by 5 feet apart, before any surface preparation occurs. The removal of sufficient concrete shall be measured by comparing the surrounding concrete to the predrilled holes. If grease or other contaminants remain on the surface, the CONTRACTOR shall scrub the surfaces with a mixture of trisodium phosphate detergent and water until the surfaces are acceptable to the INSPECTOR.
- C. Mock-Up: Before the start of the coating application, the CONTRACTOR shall perform a sample test patch (mock-up) of the surface preparation and complete coating application on an area equivalent to 25 square feet. The location of the test patch shall be pre-approved by the Coating Inspector or DISTRICT for approval prior to commencing work.
- D. Install a 1/4-inch wide by 1/4-inch deep groove in the concrete near all coating termination points such as at the bottom of a wall/column or around a pipe penetration. Dust, debris, and other contaminants shall be removed prior to primer application.

- E. In accordance with ASTM D4262, test to determine the pH of the concrete surface after the surface has been thoroughly blasted and cleaned. If the pH is outside the range recommended by the coating manufacturer, then the surface must be neutralized by removing concrete until a surface pH of 8 is obtained. One pH test shall be performed every 100 square feet, or less, and at locations determined by the INSPECTOR.
- F. The CONTRACTOR shall test for capillary moisture in accordance with ASTM D4263. Moisture tests shall be taken every 50 square feet or less and at locations determined by the INSPECTOR. If capillary moisture is present, the coating manufacturer shall be consulted to determine primer requirements and special coating application criteria.
- G. For enclosed structures with horizontal surface areas greater than 500 square feet, the CONTRACTOR shall install three anhydrous calcium chloride test kits on bare concrete to measure the Moisture Vapor Transmission Rate (MVTR) on a flat horizontal surface. Testing and calculations shall be performed according to ASTM F1869. The test kits shall be undisturbed for a minimum of 60 hours. The MVTR shall be less than 3 lbs per 1,000 square feet per 24 hours. If the MVTR is greater than 3 lbs per 1,000 square feet per 24 hours, the CONTRACTOR shall apply a concrete sealant to reduce the MVTR through the concrete or install environmental control equipment to dry the concrete for a minimum of 4 hours.
- H. The CONTRACTOR shall use Coating System RMTR to resurface the existing concrete following abrasive blasting on areas that are greater than 1/8-inch in depth or 1/8-inch in width. The existing concrete shall be resurfaced with a high early strength, epoxy-modified cement resurfacer, as specified, prior to the installation of the epoxy primer. The resurfaced concrete shall be finished with a masonry brush with 4-inch long Tampico fibers, completely cured, and dried according to the manufacturer's recommendations.
- I. After curing, and prior to coating, the resurfaced concrete shall receive a light abrasive blast per SSPC SP7 to produce a surface roughness equivalent to that of ICRI 310.2 Concrete Surface Profile 3.

3.4 SURFACE PREPARATION FOR ALUMINUM AND GALVANIZED METAL

- A. Galvanized ferrous metal shall be alkaline cleaned per SSPC-SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system to be used.
- B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP2 and power tool cleaned per SSPC SP3.
- C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.
- D. Aluminum surfaces shall be cleaned per ASTM D1730 Type B Chemical Treatment prior to coating application.
- E. The surfaces of the aluminum or galvanizing shall be abrasive blasted per SP16 prior to coating. A minimum 1.5 mil profile shall be produced and cleaned prior to the application of a protective coating.

3.5 SURFACE PREPARATION – FERROUS METALS

- A. The Shop Painting Facility shall use a minimum blast material mixture of 75% grit and 25% shot material to achieve the proper surface profile.
- B. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP7. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.
- C. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP1.
- D. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed and the surface prepared by SSPC SP2 hand tool cleaning, and SSPC SP3 power tool cleaning.
- E. The Contractor shall test the surfaces exposed to the marine atmosphere for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter ($\mu\text{g}/\text{cm}^2$). A test shall be conducted for every 100 square feet (ft^2) of surface area to be coated at locations determined by the Inspector.
- F. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate's surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.
- G. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.
- H. The minimum abrasive blasting standard shall be as specified in the coating system schedules included at the end of this section. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.
- I. The abrasive shall not be reused unless otherwise approved by the Inspector. For automated shop blasting systems, clean oil-free abrasives shall be maintained.
- J. The Contractor shall comply with South Coast Air Quality Management Owner for field abrasive blasting.
- K. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil/moisture separators which remove at least 95% of the contaminants. The Inspector shall conduct a blotter test to confirm the cleanliness of the air stream per ASTM D4285.
- L. Blast cleaned steel surfaces shall meet the manufacturer's recommended surface profile as tested using replica tape per NACE RP0287. The Inspector shall perform the surface profile tests on all bare steel as outlined in 3.10G.

- M. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming or another approved method prior to painting.
- N. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.
- O. Damaged or defective coating shall be removed by the specified blast cleaning method to meet the clean surface requirements before recoating.
- P. If the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC-SP2, hand tool cleaning or SSPC-SP3, power tool cleaning, may be used.
- Q. Shop applied coatings of unknown composition shall be completely removed before the specified coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings.
- R. Clarifier Steel: The Shop Painting Facility shall use a minimum blast material mixture of 75% grit and 25% shot material, or similar mixture, to achieve the specified surface profile.
- S. Clarifier Steel: The Shop Painting Facility shall abrasive blast the steel per SSPC SP10 on all non-immersed and immersed steel.
- T. Clarifier Steel: The Field Coating Applicator shall abrasive blast the metallic surfaces of the sludge collector arms, launder supports, turbine, center column, rake drive, and baffles and other attached metallic appurtenances, to achieve an SSPC SP7 surface profile.

3.6 SHOP COATING REQUIREMENTS

- A. Shop Priming of Ferrous Metals: Surfaces to be field sandblasted for coal tar epoxy coatings shall have no shop painting. Galvanized surfaces shall have no shop priming. All other ferrous surfaces to be field painted shall have a shop coat of primer. If shop primer is not compatible with the field paint, then said shop primer shall be removed by sandblasting and the surface shall be primed with specified primer.
- B. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP1 and SP2. Damaged shop coating shall be cleaned in accordance with SSPC SP3, Power Tool Cleaning, and recoated with the primer specified.
- C. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.
- D. All items of equipment, or parts of equipment which are not submerged in service, shall be

shop primed and then finish coated in the field after installation with the specified or approved color. The methods, materials, application equipment and all other details of shop painting shall comply with this section. If the shop primer requires top coating within a specified period of time, the equipment shall be finish coated in the shop and then touch-up painted after installation.

- E. All items of equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have all surface preparation and coating work performed in the field.
- F. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the specified quality in the field. Such equipment shall be shop primed and finish coated and touched up in the field with the identical material after installation. The Contractor shall require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these Specifications. The coating material data sheet shall be submitted with the shop drawings for the equipment.

3.7 FACTORY-PAINTED EQUIPMENT

- A. Except as otherwise noted in the Painting Schedule or specified, the following items of equipment shall receive final finish coats at the factory. Factory-painted items shall be of a color specified, selected, or accepted by the Owner.
 - 1. Chemical feeders (parts specified to have baked enamel finish)
 - 2. Chlorinators
 - 3. Cranes and hoists
 - 4. Electric switchgear and motor control centers
 - 5. Gauges and meters
 - 6. Instrument and control panels
 - 7. Instruments
 - 8. Light fixtures
 - 9. Meter panels
 - 10. Transformers
 - 11. Transmitters
- B. For certain small pieces of equipment the manufacturer may have a standard coating system which is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and

chemical metering pumps.

- C. Shop painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 6 months before topcoated, or less time if recommended by the coating manufacturer.
- D. Damage to shop-applied coatings shall be repaired in accordance with this section and the coating manufacturer's printed instructions.
- E. The Contractor shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment shop drawings.

3.8 SPRAY APPLIED COATING APPLICATION

- A. General: No exterior or interior painting shall be done under conditions which, in the opinion of the Inspector, could jeopardize the appearance or quality of the finish in any way. It may be necessary for the Contractor to provide a working area which is protected, heated, and has a controlled atmosphere.
- B. Plural Component Coatings – Only heated plural component equipment shall be used for the 100% solids coating application. Equipment shall be capable of performing a ratio test. All gauges on plural component pump shall be in working order. If defective, they shall be replaced prior to the start of any application.
- C. Plural Component Coatings – After each component of the plural component coating system has been thoroughly heated, the CONTRACTOR shall perform a paint pump ratio test on the first day of spraying and at least once a day thereafter in the presence of the Inspector. The CONTRACTOR shall place two see-through containers with preprinted volumetric marks on a flat surface. The hose valve for each component shall be opened simultaneously and each component flow rate shall be allowed to stabilize by pouring the discharging materials into separate disposable containers. After the flow is stabilized, the hoses shall be transferred to the pre-printed volumetric containers and the valves shall be shut off after one of the containers has been filled to 32 or 48 fluid ounces, depending on the mixing ratio recommended by the manufacturer. If the volumetric quantity of coating in the containers does not match the manufacturer's recommendation, the CONTRACTOR shall reduce or increase the pressure and temperature until it meets the specified mixing ratio. No spraying shall be performed until the ratio test result has been accepted by the INSPECTOR.
- D. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The CONTRACTOR shall schedule such inspection with the INSPECTOR 24 hours in advance.
- E. An independent stripe coat shall be applied to structural steel flange edges, angles, crevices, weld seams, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Particular care shall be used to ensure that the specified coverage is applied on the edges and corners of all surfaces.
- F. For metal surfaces to be submerged in water, the Field Coating Applicator shall not apply a coating on a bare steel surface that has not been prepared according to SSPC SP10 or a primed surface that has not been prepared according to SSPC SP7.

- G. The application of protective coatings to steel substrates shall be in accordance with "Paint Specification No. 1, (SSPC PA 1)", Steel Structures Painting Council.
- H. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The Contractor shall schedule such inspection with the Inspector in advance.
- I. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working week.
- J. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations, and this section, whichever has the most stringent requirements.
- K. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.
- L. Special attention shall be given to materials which will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.
- M. Finish coats, including touch-up and damage repair coats shall be applied in a manner which will present a uniform texture and color matched appearance.
- N. Steel piping shall be abrasive blast cleaned and primed before installation.
- O. Clarifier Steel: The previously shop-painted surfaces shall be abraded per SSPC SP7 after the clarifier has been erected and prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, bare metal, and areas of mechanical damage due to the installation of fasteners.
- P. Clarifier Steel: The Field Coating Applicator shall not apply a final coating on a bare steel surface that has not been prepared to an SSPC SP10 surface profile or a primed surface that has not been prepared to an SSPC SP7 surface profile.
- Q. Clarifier Steel: If stainless steel fasteners are installed, they shall be abrasive blasted per SSPC SP7 prior to the application of the final coat.

3.9 CURING OF COATINGS

- A. If necessary, the Inspector shall conduct a Solvent Rub Test in accordance with ASTM D5402 after 8 hours of curing. The test area shall be evaluated for appearance, hardness, or any color transfer to the cloth. If there is no change to the coating after the test, it will be considered cured.
- B. If necessary, the Inspector shall conduct Shore D Hardness Testing in accordance with ASTM D2240. In order to consider the coating cured and properly mixed, it must meet the manufacturer's recommended Shore D Durometer requirement for the specified product.
- C. The Contractor shall provide curing conditions in accordance with the conditions

recommended by the coating material manufacturer or by this section, whichever is the most stringent requirement, prior to placing the completed coating system into service.

- D. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.10 TESTING AND INSPECTION DURING AND AFTER APPLICATION

- A. The field and shop Contractor's QA/QC person and the Owner's Inspector shall provide anchor profile measurements, blast hose pressures, type/percent mixture of the abrasive, and shall check the compressor air cleanliness.
- B. The field and shop Contractor's QA/QC person and the Owner's Inspector shall provide a written record of the quantity of coating material applied and the corresponding surface area covered, a description of the area coated, each coating product batch number, dew point temperature, surface temperature, ambient temperature, relative humidity, and names of applicators on a daily basis.
- C. The field and shop Contractor's QA/QC person and the Owner's Inspector shall provide wet film and dry film thickness readings, results of the holiday testing, and shall note any discrepancies with the coating specifications.
- D. Inspection Devices: The Contractor shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gages shall be made available for the Inspector's use at all times while coating is being done, until final acceptance of such coatings. The Contractor shall provide the services of a trained operator of the holiday detection devices until the final acceptance of such coatings.
- E. Holiday Testing: The Contractor shall holiday test all coated ferrous surfaces, or other surfaces which will be submerged in water or other liquids, or concrete surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems in the presence of the Inspector. Areas which contain holidays shall be marked and repaired or recoated and retested in accordance with the coating manufacturer's printed instructions.
 - 1. Coatings With Thickness Exceeding 20 Mils: For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. Holiday testing shall be conducted with a new 12-inch or 18-inch wide wire brush electrode attached to the unit. A silicon rubber electrode shall not be allowed. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.
 - 2. Coatings With Thickness of 20 Mils or Less: For surfaces having a total dry film coating thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flo, or equal, shall be added to the water prior to wetting the detector sponge.

- F. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gage. The instruments shall have the capability of measuring 50% over the specified coating thickness and shall produce an actual reading and shall not be estimated. No measurements shall be made until at least 8 hours after application of the coating. The following instruments are acceptable:
1. Concrete Surfaces
 - a. Wet – Notched gauge per ASTM D4414, or approved equal
 - b. Dry – PosiTector 200, or approved equal
 2. Ferrous and Non Ferrous Surfaces
 - a. Wet – Notched gauge per ASTM 4414, or approved equal
 - b. Dry – Elcometer Model 456, PosiTector 6000, or equal
- G. Steel Surface Preparation Profile: For every 500 square feet or less of steel surface blasted, as determined by the Inspector, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed within a single test area 12 inches in diameter. For each test area, the three replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.
- H. Concrete Coating Adhesion Testing – For every 500 square feet of coating material applied, or fraction thereof, the coating adhesion to the concrete substrate shall be tested per ASTM D 4541 using Type II or Type V instruments, Elcometer 106 or Defelsko Positest ATM or equal, by the Inspector. The procedure is as follows:
1. A minimum of one 20-mm diameter dolly shall be affixed to the coated surface within the structure for every 200 square feet or more, as mutually agreed by the Owner and the Contractor. Each testing location shall be identified and recorded by the Inspector.
 2. Prior to conducting the pull-off test, the Inspector shall score around the dolly without disturbing the dolly or bond within the test area. The scoring shall penetrate through the newly applied coating, and abrade the substrate.
 3. The adhesive used to attach the dollies to the liner shall be rapid setting with a tensile strength in excess of the coating material and permitted to cure in accordance with the manufacturer's recommendations. The lining material and dollies shall be adequately prepared to receive the adhesive. Failure of the dolly adhesive shall require re-testing.

4. The adhesion pulls shall exceed 200 psi with concrete failure with more than 50% of the subsurface adhered to the coating. Pull tests with results between a minimum 150 psi and 200 psi shall be acceptable if more than 50% of the subsurface is adhered to the back of the dolly. If two dollies do not meet the adhesion requirements, an additional location shall be tested on the same surface. If 60% of the adhesion tests fail to meet the adhesion requirements, the liner shall be removed and replaced at the Contractor's expense.
5. The Inspector shall record the type of adhesive used, the length of time the adhesive was allowed to cure, and the type of failure observed on the dolly.
6. The CONTRACTOR shall repair the coating or lining at the locations of the adhesion tests per the manufacturer's recommendations. The testing dollies shall be retained by the Coating Inspector at the conclusion of the testing.

3.11 WARRANTY INSPECTION

- A. The Contractor and coating manufacturers shall warrant the coating system applications against defects and workmanship after final acceptance of the Work for a period of 2 years. The Contractor shall perform all Work and supply all equipment and materials associated with the repair of failures identified in the warranty inspection at no cost to the Owner.
- B. A warranty inspection may be conducted prior to expiration of the 2 year warranty period after final acceptance of all coating work. The Contractor and a representative of the coating material manufacturer shall attend this inspection at no cost to the Owner. All defective work shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Owner may by written notice to the Contractor, reschedule the warranty inspection, or may cancel the warranty inspection altogether. If a warranty inspection is not held, the Contractor is not relieved of its responsibilities under the Contract Documents.
- C. A total of two (2) inspections will be required at locations chosen by the Owner and can include any or all surfaces. The Owner will be responsible for dewatering and providing access, and for performing the inspection and testing. The inspection will include thorough visual inspection to identify pin holes, delaminations or other product or installation defects. The Owner, at its sole discretion, may choose to perform bond strength testing per ASTM D4541. The Contractor shall conduct repairs to coated surface per the manufacturer's recommendations and the repaired surfaces shall be subject to inspection by the Owner.

3.12 CURING OF COATINGS

- A. If necessary, the Inspector shall conduct a Solvent Rub Test in accordance with ASTM D5402 after 8 hours of curing. The test area shall be evaluated for appearance, hardness, or any color transfer to the cloth. If there is no change to the coating after the test, it will be considered cured.
- B. If necessary, the Inspector shall conduct Shore D Hardness Testing in accordance with ASTM D2240. In order to consider the coating cured and properly mixed, it must meet the manufacturer's recommended Shore D Durometer requirement for the specified product.
- C. The Contractor shall provide curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this section, whichever is the most

stringent requirement, prior to placing the completed coating system into service.

- D. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.
- E. The contractor shall provide a letter to the Owner, prior to disinfection, stating that the coatings are fully cured and ready to be placed into service.

3.13 COATING SCHEDULE

Facility	Structure type - material	Lining System	Coating System	Surface Preparation
Influent Sewer and other PVC or HDPE pipe	PVC and HDPE	N/A	E1	SP2
Headworks	Vapor Space and 2 feet below waterline	PVC	N/A	See Section 06620
Primary Clarifier	Immersed Steel	E1 and E2	N/A	SP10 with the 2 mil profile
	Non-Immersed Steel	N/A	EAP	SP10 with the 2 mil profile
Equalization Basin No. 1 and No. 2	Vapor Space and 2 feet below waterline	PVC	N/A	See Section 06620
Trickling Filters	Concrete	E100 or P100	N/A	SP13 abrasive blast and ICRI 310.2 Concrete Surface Profile 4 to 5
Steel (process waste) –above ground –below ground	Diameter 24 inches or less	See Section 02571 CML. FBE or E1 as called out in Drawings only	See Section 02571 CML. EAP (sun exp) E2 (no sun exp) FBE or P100 as called out in the Drawings only.	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
Pipe, Cast Iron Fittings, Mechanical Joints (process waste) –above ground –below ground	Steel, Cast Iron, Ductile Iron	E4	EAP (sun exp) E2 (no sun exp) 6 to 24-inch diam.=FBE	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
Ductile Iron Pipe (process waste) –above ground –below ground	Ductile Iron	Dia 18 inches or less = DIP1 or DIP2 (low solids) Dia 18 inches or less = DIP 3 (sludge)	EAP (sun exp) E2 (no sun exp and non-immersed)	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
304 Stainless Steel and Galvanized Metals subject to splash zones or sewer gases	Welds, abutments of dissimilar metals	N/A	E2	SP16 OR SP 11
Valves exposed to marine or splash environment	Cast Iron or Ductile Iron valves	VAL1	E1 or FBE	Interior – SP10 with the 2 mil profile Exterior – SP6 with the 2 mil profile
Buried Cast Iron and Steel Fittings, couplings and pipe restraints	Buried Metal	FBE	Shop – E1 Field – PT	Interior – SP5 Exterior Shop – SP5 Exterior Field – SP3

Facility	Structure type - material	Lining System	Coating System	Surface Preparation
Foul Air Ducting	FRP	None	EAP (sun exp) E2 (no sun exp)	Exterior – SP 2 and SP3
Existing Manhole on Drawing C-100	Concrete	RMTR and P100 or E100 at 125 mils DFT	-	SP13 abrasive blast and ICRI 310.2 Concrete Surface Profile 4 to 5
Optional Bid Item - Existing Fixed Film Reactors	Concrete	RMTR and P100 or E100 at 125 mils DFT	-	SP13 abrasive blast and ICRI 310.2 Concrete Surface Profile 4 to 5

END OF SECTION

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SECTION 09970 – SHOP PAINTING OF HOT-DIPPED GALVANIZED STEEL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and incidentals required to apply shop-applied paint on structural steel, miscellaneous and ornamental metal which is exposed to view and is hot-dipped galvanized; including requirements for substrate surface preparation and related activities, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05120, Structural Steel
- B. Section 05500, Miscellaneous Metals
- C. Section 09960, Protective Coatings

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM International (ASTM):
 - 1. ASTM A123 – Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A153 – Standard Specification Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 3. ASTM A384 – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
 - 4. ASTM A780 – Standard Practice for Repair of Damage and Uncoated Areas of Hot-Dipped Galvanized Coatings.
 - 5. ASTM B201 – Standard Practice for Testing Chromate Coatings of Zinc and Cadmium Surfaces.
 - 6. ASTM D6386 – Standard Practice for Preparation of Zinc (Hot-Dipped Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
 - 7. ASTM E376 – Standard Practice for Measuring Coat Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Examination Methods.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

- A. Submit to the ENGINEER, in accordance with Division 1, the following information:

1. Samples – Submit two sets of color samples of factory-applied coatings proposed for use for review prior to coating applications.
2. Certificates:
 - a. Provide certification listing materials used in coating systems and certify compliance with standards designated.
 - b. Provide certification stating materials provided comply with requirements of this section.

1.5 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies – Provide and apply materials complying with environmental requirements of the State of California and the authority having jurisdiction.
- B. Mock-up Surface Areas – Sample item may be designated as control for color, texture, and application for each paint system with the accepted item used as criteria for similar items, which shall match accepted mock-ups.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver paint materials to galvanizer with label or product data sheet affixed to the manufacturer's containers showing manufacturer's name, type of paint, stock number, batch number, label analysis of solids and vehicle, reducing instructions, thinning instructions, drying and recoat time, application instructions with recommended methods, environmental restrictions, Safety Data Sheets, and Paint System Number assigned in Contract Documents.
- B. Store paint materials in an accepted location reserved only for such materials and related equipment in compliance with applicable health and fire regulations of authorities having jurisdiction.
- C. Any containers showing damage to the extent that spillage content is visible shall be rejected and removed permanently from site.

1.7 APPLICATION CONDITION

- A. Apply primer hot-dipped galvanizing within 12-hours after galvanizing in the galvanizers facility in accordance with specified requirements and recommendations of the galvanizer.
- B. The primer and top coat shall be applied in the following conditions unless manufactures recommendations are more stringent:
 1. Minimum air temperature shall be 65 degrees-Fahrenheit. Surface temperature of steel shall be 60-90 degrees-Fahrenheit, an in any event, be 50 degrees-Fahrenheit higher than the dew point. Humidity shall be 85% maximum.
 2. Surface steel shall be dry and free from dust, dirt, oil, grease, or other contaminants. Coating and cure facility shall be maintained free of airborne dust

and dirt until coatings are completely cured.

3. The primer shall be applied by way of plural component airless spray over a consistent surface profile, 1.5-mil minimum. The profile shall be measured and permanently recorded, with Test-Ex tape.
 4. The use of iron or steel shot and sand and aluminum oxide grit as blast medium, and power wire brushes are not permitted.
- C. The galvanizer/galvanizing facility shall have a dedicated, on-premise painting and curing facility for the exclusive use of coating galvanized steel. Said facility shall utilize the following:
1. Recording hygrometer to measure air-temperature and humidity.
 2. A spray booth conforming to OSHA regulations with filtered exhaust.
 3. A convection hot air curing system with solvent vapor removal ability.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

2.2 HOT-DIPPED GALVANIZING

- A. Provide coating for iron and steel fabrications applied by the hot-dip process. Comply with ASTM A123 for fabricated products and ASTM A153 for hardware. Provide thickness of galvanizing specified in referenced standards.

2.3 FACTORY APPLIED PRIMER OVER HOT-DIPPED GALVANIZING

- A. Provide factory-applied polyamide epoxy primer, 3.0 mils dry film thickness minimum. Apply primer within 12-hours after galvanizing at the galvanizer's facility in a controlled environment meeting applicable environmental regulations and as recommended by the coating manufacturer.
- B. Engage the services of a galvanizer who has demonstrated a minimum of five years experience in the successful performance of the process outlined in this Section in the facility where the work is to be done. And who will apply the galvanizing and coating within the same facility as outlined herein.

PART 3 EXECUTION

3.1 APPLICATION OF GALVANIZING AND METAL COATINGS

- A. Galvanize materials in accordance with referenced standards and this Section.
- B. Galvanizing shall provide an acceptable substrate for applied coatings.

- C. The dry kettle process shall be used to eliminate any flux inclusions on the surface of the galvanized materials. Prior to galvanizing, the steel shall be immersed in a pre-flux solution (zinc ammonium chloride). Use of the wet kettle process shall not be permitted.
- D. To provide the galvanizing surface required, the following procedures, at a minimum, shall be implemented:
 - 1. A monitoring recorder shall be utilized and inspected regularly to observe any variances in the galvanizing bath temperature.
 - 2. The pickling tanks shall contain hydrochloric acid with a constant range between 10-14%, iron content less than 8%, and zinc content less than 3%. Titrations shall be taken weekly at a minimum.
 - 3. Rinse tanks, for the removal of cleaning chemicals, shall contain water.
 - 4. Water quenching or chromate conversion coating of galvanized steel shall be prohibited.
- E. The primer and topcoat material shall be certified VOC compliant and conform to all environmental and EPA requirements.
 - 1. The primer shall be a high solid polyamide epoxy applied to a DFT of 3 mils minimum.
 - 2. The topcoat shall be a color pigmented, two-component high build aliphatic polyurethane applied to a DFT of 3 mils minimum.

3.2 QUALITY CONTROL

- A. Inspection:
 - 1. Measure representative areas for DFT.
 - 2. If thickness of coating does not comply with DFT requirements, apply additional applications of coating to attain specified DFT at no additional cost to DISTRICT.
 - 3. Where characteristics of coating prohibit recoating, remove and replace unacceptable coating(s) at no additional cost to the DISTRICT.
 - 4. Where application of coating exceeds DFT and is considered detrimental to quality of the Project, in the opinion of the ENGINEER, remove and recoat to specified DFT at no additional cost to the DISTRICT.
 - 5. Where measurement of DFT is impractical or impossible, determine the amount of coating necessary from manufacturer's published spreading rate calculate to specified DFT.
 - 6. The manufacturer's stock and batch number will be compared with the assigned Paint System Number with color sample submitted for finished surfaces, and with mock-up for finished surfaces in accordance with the requirements of this Section.

- B. Installation – Comply with fabricator's and galvanizer's requirements for installation of materials and fabrications, including use of nylon slings or padded cables for handling factory or factory-finished materials.
- C. Touch-up and Repair – For damaged and field welded metal coated surfaces, clean welds, bolted connections and abraded surfaces. The maximum area to be repaired shall be in accordance with ASTM A123.
 - 1. At galvanizing surfaces, apply organic zinc repair paint complying with requirements of ASTM A780. Galvanizing repair paint shall have 95 percent zinc by weight. Thickness of applied galvanizing repair paint shall be not less than coating thickness required by ASTM A123 or A153 as applicable. Touch-up galvanizing surfaces with aerosol spray, silver paint, bright paint, brite paint, or aluminum paints is prohibited.
 - 2. At factory-primed or factory-finished surfaces, touch-up finish in conformance with manufacturer's recommendations. Provide touch-up such that repair is not visible from a distance of six-feet.
 - 3. The galvanizer/galvanizing facility shall have an ongoing touch-up and repair program acceptable to the ENGINEER, which has been in effect for a minimum of five years.
 - 4. A touch up repair kit shall be provided with each order.

END OF SECTION

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SECTION 10400 – IDENTIFYING DEVICES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide signs and other identifying devices and all appurtenant work, complete and in place, in accordance with the Contract Documents.
- B. Identifying devices required by other Section of the Specifications shall also comply with this Section.

1.2 CONTRACTOR SUBMITTALS

- A. General: The CONTRACTOR shall furnish submittals in accordance with the requirements of Section 01300 – Submittals.
- B. Shop Drawings: Full-size or scaled layouts of signs showing sign size, color, fasteners and mounting, and location. A typical of repetitive sign layouts may be submitted. Most restrictive conditions shall be depicted.
- C. Samples: Samples of all the materials and colors proposed for the Work, clearly marked to show the manufacturer's name and product identification along with the manufacturer's technical data and application instructions.

PART 2 PRODUCTS

2.1 GENERAL

- A. Identification devices shall be installed where directed by the ENGINEER. All wording shall be as indicated and shall be verified before fabrication.

2.2 BUILDING/ROOM NAMEPLATES

- A. Nameplates shall be Builders Brass Works, Vornar Products, Inc., or equal, with colored 1/8-inch acrylic plastic (matte finish). Lettering shall be white, 1/2-inch high, or 36 points, and shall be fused by heat and pressure to a depth of approximately 0.005-inch. Plates shall be installed in an extruded aluminum frame, medium bronze or dark anodized finish, and be provided with 2-way adhesive mounting tape. Plastic color and letter style shall be as selected by the ENGINEER. Provide and install a total of 15 nameplates to be defined and selected by the ENGINEER.

2.3 EQUIPMENT, TANKS, VALVE, AND GATE IDENTIFICATION

- A. All equipment, tanks, valves, and gate with P&ID tag numbers and names shall be installed with labels (after finish painting). The label shall include the P&ID tag and the common name (e.g. Filter Feed Pump). Identification of shall be provided by application of labels of adhesive-backed vinyl cloth. Adhesive will be recommended by the manufacturer for application to the specified coating systems.
 - 1. Each equipment, tank, valve or gate shall have a preprinted label to identify the item.

2. Letter sizes shall be 1 inch for equipment and gates, 2 inches for tanks, 1/2 inch for valves and small equipment.

2.4 SIGNS

- A. General: Signs or warning shall be enamel painted on semi-rigid butyrate. Signs shall conform to OSHA Standards and directions. Lettering sizes shall be 3-inch in height unless indicated otherwise herein.
- B. The following sign shall be furnished for installation where directed by the ENGINEER:

Sign	Quantity
EXIT	2
DANGER PERMIT REQUIRED CONFINED SPACE	6
CAUTION NON-POTABLE WATER DO NOT DRINK	8
WARNING THIS EQUIPMENT STARTS AUTOMATICALLY	12

2.5 LETTERS

- A. Metal: Letters shall be 3-inch anodic finish aluminum of medium bronze. Letters shall be provided complete with fasteners for concrete wall installation at the locations identified by the CONSTRUCTION MANAGER. Letters shall be provided for the following process areas:
 1. HEADWORKS
 2. PRIMARY CLARIFIER NO. 2
 3. ELECTRICAL ROOM
 4. EQUALIZATION BASIN
 5. EFFLUENT FILTERS
- B. Plastic: Plastic Letter shall be 3-inch Helvetica Medium lower case cut from 1/4-inch thick acrylic plastic, finished with auto paint coating of color selected by Owner.

2.6 MATERIALS

- A. Equipment Nameplates: Engraved or stamped and fastened to the equipment in an accessible location with No.4 or larger oval-head stainless steel screws or drive pins.
- B. Plastic Tags and Plates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

- C. Metal Tags: Brass with stamped letters, tag size minimum 1-1/2 inch in diameter with finished edges
 - D. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches outside diameter of insulation or pipe: 1/2-inch-high letters.
 - 2. 2-1/2 to 6 inches outside diameter of insulation or pipe: 1-inch-high letters.
- 2.7 MANUFACTURERS:
- A. Craftmark Identification Systems
 - B. Safety Sign Co.
 - C. Seton Industrial Products

PART 3 EXECUTION

3.1 GENERAL

- A. All installation of identifying devices shall be vandal-resistant. Fasteners shall be concealed, non-corrosive fasteners appropriate for materials being fastened and as required.

3.2 INSTALLATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Install in accordance with the MANUFACTURER's printed instructions.
- C. Install identifying devices after completion of coverings and painting.
- D. Install plastic nameplates with corrosive-resistant mechanical fasteners or adhesive.
- E. Install labels with sufficient adhesive for permanent adhesion, and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- F. Install tags using corrosion-resistant chain. Number tags consecutively by location.
- G. Identify generator set with plastic nameplate. Identify in-line pumps and other small devices with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Tag automatic controls, instruments, and relays.

3.3 LETTERS

- A. Installation of metal letters shall be 3/4-inch projection mounted from concrete block wall surface with threaded studs and space collars. The center of each row shall align. Letters shall be installed per MANUFACTURER's published instructions.

END OF SECTION

SECTION 11000 – EQUIPMENT GENERAL PROVISIONS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.
- B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.
- C. Package System Conduit Coordination: The package equipment vendors shall be responsible for coordination of field conduit and wiring. The vendors shall review the electrical drawings prior to bid and identify field conduit and wire that is required for the respective equipment package. If the field conduit and wire required to install the vendors package is not specifically shown on the electrical drawings, the vendor shall be responsible for providing and installing the necessary additional field conduit and wiring. The conduit, fittings, and boxes supplied by the vendor shall meet the code requirements for the area hazard classification defined in the electrical design documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All work specified herein shall conform to the requirements of all applicable codes and regulations.
- B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications:
 - 1. ASTM International (ASTM).
 - 2. American Public Health Association (APHA).
 - 3. American National Standards Institute (ANSI)
 - 4. American Society of Mechanical Engineers (ASME).
 - 5. American Water Works Association (AWWA).
 - 6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
 - 7. American Welding Society (AWS).
 - 8. National Fire Protection Association (NFPA).

9. Federal Specifications (FS).
10. National Electrical Manufacturers Association (NEMA).
11. Manufacturer's published recommendations and specifications.
12. General Industry Safety Orders (OSHA).
13. American Petroleum Institute (API)
14. Hydraulic Institute (HI)

C. The following standards have been referred to in this Section of the specifications:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
ANSI B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ANSI/ASME B1.20.1	General Purpose Pipe Threads (Inch)
ANSI/ASME B31.1	Power Piping
ANSI/AWWA D100	Welded Steel Tanks for Water Storage
AWWA C206	Field Welding of Steel Water Pipe
ASTM A 48	Specification for Gray Iron Castings
ASTM A 108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the Engineer in accordance with Section 01300 - Submittals.
- B. Operators and Maintenance Manual: The Contractor shall provide operations and maintenance manual for all equipment furnished for the project. The data shall be compiled into multiple three-ring binders. Refer to specification Section 01300 Submittals for specific requirements.
- C. Tools: The Contractor shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the

equipment. All tools shall be of best quality hardened steel forgings with bright, finish wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover.

- D. Spare Parts: The Contractor shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After approval, Contractor shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the Owner, only after expiration of the guaranty period.
- E. Torsional Analysis: The Contractor shall submit to the Engineer a torsional and lateral vibration analysis of the following equipment, in accordance with Section 01300 Submittals. The analysis has to be performed by a specialist experienced in this type of work and approved by the Engineer.
 - 1. All engine drives.
 - 2. All blowers and compressors with drives of 100 horsepower and over.
 - 3. All vertical pumps with universal joints and extended shafts.
 - 4. All other equipment where specified.
 - 5. The torsional natural frequency of the drive train must be avoided by + 25 percent by any exciting frequency of the equipment, throughout the entire operating range.
- F. Vibration Analysis: In his bid price the Contractor shall include at least two site visits of the abovementioned specialist, during construction and testing of the equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.
- G. Electrical and Control Submittals:
 - 1. Electrical and control submittals shall meet the applicable requirements of Section, Electrical, and Section, Instrumentation and Controls.
 - 2. All submittals shall include the device tag number and/or equipment number as shown on the Contract Documents.
 - 3. Include complete information on electric power requirements. Include information on required branch circuits and electric feeders, voltages, loads, and specific locations of terminations. If disconnecting devices are required, provide information on these requirements.
 - 4. Provide complete information on signal inputs and outputs: discrete (contact closures), and analog (4-20 milliamp signals).

5. Provide a functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled or alarmed. Include information on programmed and/or configured controls.
6. Provide a bill of materials, which is a listing that includes all of the control stations, panels, racks, instruments, components, and devices provided under this Section. Components on and within panels shall be included on the bill of materials for the panel. All components shall be grouped by component type, with the identification code and/or tag number used on the Contract Drawings where so shown. For devices not identified on the Contract Drawings with unique tag numbers, the supplier shall assign tag numbers consistent with (and not conflicting with) the tag numbers in use on the project. The list shall contain the following, as a minimum:
 - a. Instrument, panel, rack or device, tag number
 - b. Description
 - c. Quantity supplied
 - d. Reference to component datasheet and/or catalog cut
 - e. Component type
7. Provide complete submittal information on control stations, control panels, field panels, instrument racks, and other control enclosures.
8. Provide panel construction drawings, including shop drawings and catalog material. Drawings shall include dimensions and shall show the location of all panel-mounted devices as well as doors, hinges, fasteners, louvers, and subpanels. Drawings shall include a panel legend and a bill of materials. The panel legend shall list and identify front-of-panel devices by their assigned tag numbers and nameplate inscriptions. The bill of materials shall list all devices mounted within the panel that are not listed in the panel legend, and shall include the tag number, description, manufacturer, and model number for each.
9. Electrical Drawing Requirements:
 - a. Electrical drawings and data shall be complete, shall represent the equipment proposed for this project, and shall meet the applicable requirements of Section 16000 - Requirements for Electrical Work , and Section 13400 - Instrumentation and Control System. Drawings and data shall be adequate to demonstrate that the equipment meets the requirements of the Contract Drawings and Specifications, and also to be used by the Owner for operation, maintenance, and troubleshooting of the facility.
 - b. Provide electrical schematic diagrams and wiring diagrams as described in Section 16000 - Requirements for Electrical Work. They shall show locations and wiring for items specified in this Section, and also show interface wiring between items specified in this Section and other items on this project. Electrical schematic diagrams shall show circuits and device elements in ladder-diagram form without regard to physical location. Wiring diagrams shall show the connections and physical relationship of electrical devices and apparatus in circuits or groups of circuits within each control panel or other identifiable unit of equipment.

- c. For electrical schematic and wiring diagrams, manufacturer's standard drawings may be used, provided that they show the information required and are annotated to reflect the configuration for this project. For example, equipment numbers and descriptions unique to this project should be used, options not included should be stricken, signal interfaces with systems outside this package should be marked up to depict the actual interfaces on this project, information and detail should be added to meet the requirements above, and other standard and optional provisions should be annotated to match this project.
- d. Electrical drawings and data shall be identified with the device tag number and/or equipment number as shown on the Contract Documents, or otherwise shown.

10. Field Wiring Interconnection Diagram:

- a. As described in Section 16000 - Requirements for Electrical Work, participate in the development of field wiring interconnection diagram(s). Provide detailed information showing termination provisions.

11. Interface and Interconnection Coordination

- a. The supplier of the system described in this Section shall coordinate with other members of the Contractor's organization during bid and during construction on interfaces and interconnection requirements. The requirements below are not comprehensive, but instead represent minimum requirements:
- b. Coordination of power feed(s): If disconnects and/or overcurrent protection are shown and/or otherwise required, and they are not provided by the supplier of the equipment specified herein, coordinate the source of supply. Required disconnects shall be provided under this Contract. If branch circuits and/or feeders required differ from what is shown on the Contract Documents, provide power feeds as required to supply the package.
- c. Coordination of interconnection within package components: If any devices within the package are not factory wired, and/or are to be field wired, coordinate source of supply and provide complete documentation showing the interconnection. Required interconnection shall be provided under this Contract.
- d. Coordination of interfaces and interconnections outside of the package: Provide complete coordination and information necessary to document and execute signal interfaces between the package and the remainder of the facility. Coordinate signal levels, ranges, and contact senses. For analog signals, coordinate power source.
- e. Motor Control: If any motor control is required outside of the package, Contractor shall coordinate requirements and interfaces. Required motor control, complete, shall be provided under this Contract.

1.4 QUALITY ASSURANCE

- A. Inspection, Startup, and Field Adjustment: The Contractor shall demonstrate that all equipment meets the specified performance requirements. Contractor shall provide the services of an experienced, competent, and authorized service representative of the

manufacturer of each item of major equipment who shall visit the site of Work to perform the following tasks:

1. Assist the Contractor in the installation of the equipment.
 2. To inspect, check, adjust if necessary and approve the equipment installation.
 3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
 4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
 5. To instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.
- B. Costs: The costs of all inspection, startup, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the Contractor. The Owner will pay for costs of power and water. When available, the Owner's operating personnel will provide assistance in the field testing.
- C. Public Inspection: It shall be the responsibility of the Contractor to inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, etc., to obtain all required permits and certificates, and pay all fees.
- D. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.
- E. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
 2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
 3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

1.5 MANUFACTURER'S EXPERIENCE:

- A. Unless otherwise directed by the ENGINEER, all equipment furnished shall have a record of at least 5 years of successful, trouble free operation in similar applications, from the same manufacturer.
- B. The manufacturer shall also have sufficient installation experience and financial stability to ensure long-term capability to furnish, install, and service the equipment.

1.6 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Inspection, Startup, and Field Adjustment: Where required by the equipment 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 equipment 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 two year's experience in training. A resume for the representative shall be submitted.
 3. Training shall be scheduled a minimum of three 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.

PART 2 PRODUCTS

2.1 GENERAL

- A. High Noise Level Location: The Contractor shall provide one personal hearing protection station, as specified herein, at each high noise level location. Said locations are defined as follows:
1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station. For any equipment provided that exceeds a noise level of 85 dBA @ 3 feet, the Contractor shall provide and install a weatherproof sound dampening enclosure. The enclosure shall be capable for reducing noise levels for the operating equipment to less than 85 dBA @ 3 feet and shall include adequate access and ventilation openings and/or doors for operation and maintenance. Sound enclosures shall be provided at no additional cost to the District and shall be submitted to for review and approval in accordance with Section 01300 - Submittals.
 2. Indoor Location:
 - a. Any single equipment item, or any group of equipment items, located within a single room not normally occupied, that produces noise exceeding OSHA noise level requirements for a 2-hour exposure.
 - b. Any single equipment item, or any group of equipment items, located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8-hour exposure.
- B. Personal Hearing Protection: The Contractor shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise producing equipment.
- C. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise specified, the following load classifications shall apply in determining service factors:

Type of Equipment	Load Classification
Reciprocating Air Compressor:	
Multi-Cylinder	Moderate Shock
Single-Cylinder	Heavy Shock
Pump:	
Centrifugal or Rotary	Uniform
Reciprocating	Moderate Shock

Type of Equipment	Load Classification
Crane or Hoist	Moderate Shock

- D. For service factors of electric motors, see Section 16222 - Motors. Where load classifications are not specified, best modern practice shall be used.
- E. Welding: Unless otherwise specified or shown, all welding shall conform to the following:
1. Latest revision of ANSI/AWWA D100.
 2. Latest revision of AWWA C206.
 3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
 4. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
 5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.
- F. Protective Coating: All equipment shall be painted or coated in accordance with Section 09960 – Protective Coatings, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
- G. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.
- H. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Engineer-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind and seismic loads as specified on Drawing S-1. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent

of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise directed.

- B. Equipment Foundations: Equipment foundations shall be as per manufacturer's written recommendations. All mechanical equipment, tanks, control cabinets, etc., shall be mounted on minimum 3.5-inch high concrete bases, as shown on standard structural details, unless otherwise shown or specified.
- C. Shop Drawings: Shop drawings shall be submitted to the Engineer for review in accordance with the requirements of Section 01300 - Submittals. Shop drawings will be considered incomplete unless clear, concise calculations are presented showing equipment anchorage forces and the capacities of the anchorage elements provided by the Contractor.

2.3 PIPE HANGERS, SUPPORTS AND GUIDES

- A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with the requirements of Section 15006 - Pipe Supports.

2.4 FLANGES AND PIPE THREADS

- A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise shown. All pipe threads shall be in accordance with ANSI/ASME B1.20.1, and with requirements of Section 15000 – Piping, General.

2.5 COUPLINGS

- A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.
- B. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.
- D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.6 SHAFTING

- A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

- B. **Materials:** Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an equipment assembly.
1. Low carbon cold-rolled steel shafting shall conform to ASTM A108, Grade 1018.
 2. Medium carbon cold-rolled shafting shall conform to ASTM A108, Grade 1045.
 3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- C. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

2.7 BEARINGS

- A. **General:** Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
- B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.
- C. All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
- D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.
- E. **Bearing Life:** Except where otherwise specified or shown, all bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so specified, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)	L-10 Design Life (hours) (whichever comes first)
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

- F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.
- G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.8 GEARS AND GEAR DRIVES

- A. Unless otherwise specified, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the Engineer.
- B. All gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.
- C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.
- E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.
- F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the Contractor shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.9 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.
- C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.
- D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

- A. General: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.
- B. Materials: Unless otherwise specified, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
 3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A48, Class 30.
- C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.
 - D. Finish bored sprockets shall be furnished complete with keyseat and set screws.
 - E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.
 - F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.
- 2.11 V-BELT DRIVES
- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.
 - B. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.
 - C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.
 - D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.
 - E. Finish bored sheaves shall be furnished complete with keyseat and set screws.
 - F. Sliding motor bases shall be provided to adjust the tension of V-belts.
- 2.12 DRIVE GUARDS
- A. All power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the Division of Industrial Safety General Industrial Safety Orders latest edition and OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10 gage expanded, flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of the Section 15000 - Piping, General.

2.14 INSULATING CONNECTIONS

- A. Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 15000 - Piping, General.

2.15 GASKETS AND PACKINGS:

- A. Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N", grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:

1. Color - Jet Black.
2. Surface - Non-blooming.
3. Durometer Hardness - 74 ± 5
4. Tensile Strength – 1000 psi Minimum
5. Elongation – 175 percent Minimum

- B. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D2000, AA709Z, meeting Suffix. B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

- C. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Gatlock No. 432, John Crane "Everseal," or equal.

- D. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the Engineer, in accordance with Section 11100 – Pumps, General.

2.16 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

- A. Where work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.

2.18 OVERLOAD PROTECTION

- A. General: Unless otherwise specified in individual equipment Sections, all equipment drives incorporating overload protection shall be provided with an overload protection device as follows:
 - 1. Mechanical System: The overload protection shall be a mechanical device to provide for reliable protection in the event of excessive overload. It shall be a ball detent type designed for long-term repeatability and life. It shall be infinitely adjustable by a single adjusting nut. Once set it shall be tamperproof, and incorporate a torque monitoring and control system. It shall activate an alarm set for 85 percent, and a motor cutout switch set for 100 percent of maximum continuous running torque. A visual torque indication shall be provided and oriented so that it may be read from the walkway. The dial shall be calibrated from 0 to 100 percent of maximum continuous running torque. The design of the torque limiter should initiate the mechanical disengagement of the drive upon overload. Each unit shall be suitable for outdoor/corrosive environments with a protective finish, corrosion inhibiting lubricants and a stainless steel cover.
 - 2. Electronic System
 - a. As an alternative to the mechanical system, the overload protection may be an Electronic Torque Monitoring Control System capable of displaying torque, rpms, one level of overload, and two levels of overload of the drive system. It shall incorporate a time-delay for startup and a voltage monitoring and compensation circuit for up to +15 percent variation.
 - b. The overload device shall have an enclosure suitable for outdoor installation at temperatures of 0-70 degrees C, and relative humidity up to 95 percent. A visual torque dial shall be provided and oriented so that it can be easily read from the walkway.
 - c. The torque monitoring system shall be calibrated to: alarm and shut down the system in the event the torque drops to 50 percent of normal running; alarm at 85 percent of maximum continuous running torque and shut down the motor at maximum continuous running torque of the equipment. The system shall be calibrated at the factory of the equipment manufacturer and it shall be capable of monitoring twice the maximum continuous running torque of the equipment.
- B. Manufacturers, or Equal:
 - 1. American Autogard Corporation.
 - 2. Ferguson Machine Company.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the Owner no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.
- B. The Contractor shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.
- C. Equipment furnished shall be shipped to the site in enclosed, weather-tight, sealed containers in a manner designed to protect the pumping units against damaging stress caused by sudden acceleration or deceleration. For equipment 25 horsepower or greater, two recording accelerometers, designed to record the magnitude of any sudden impact in all three directions (X, Y, Z) on continuous strip charts, shall be shipped with, and fixed to each assembly or its packing container. Upon arrival of each shipment, the accelerometers shall be removed in the presence of representatives of the Engineer, the Contractor, and the equipment manufacturer. If magnitude of the maximum acceleration exceeds 3.0 times the acceleration due to the force of gravity (3.0 g), the assembly or subassembly shall be dismantled and completely inspected. All damage shall be corrected to the complete satisfaction of the Engineer before the assembly is incorporated in to the work. The Contractor shall bear all costs arising out of dismantling, inspection, repair, and reassembly.
- D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to project through the box or crate so that attachment to the hoisting equipment can be readily made.
- E. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
- F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.

- G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.
- H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.
- I. Each equipment shall be properly crated to protect the units against damage during shipment.

3.2 INSTALLATION

- A. Install in accordance with the manufacturer's printed instructions.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Equipment 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.
- D. The Contractor shall accomplish installation with assistance from the Manufacturer.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650 - Facility Startup.
- B. Factory Testing
 - 1. The Contractor shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.
 - 2. The following tests shall be conducted on each indicated system:
 - a. Equipment Systems: All equipment systems 10 hp and larger shall be tested at the factory in accordance with the applicable American National Standard. Tests shall be performed using the complete system to be furnished, including the motor. For motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable.
 - b. Factory Witnessed Tests: All equipment, variable speed drives, and motors, 125 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. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed test procedure. All costs for OWNER and ENGINEER shall be borne by the OWNER. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER.

- c. Acceptance: In the event of failure of any equipment 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 at no additional cost to the OWNER until found satisfactory.

C. Functional Testing

1. The CONTRACTOR shall bear all costs of the functional 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 functional testing. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.
2. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.
3. Functional testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ ENGINEER two weeks prior to the scheduled functional field test date.
4. At least 2 weeks prior to the test, Contractor shall submit for review and approval a copy of the proposed functional test procedure.
5. The following functional testing shall be conducted:
 - a. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is specified.
 - b. The equipment shall operate as described under the control strategy outlined in the instrumentation specification.
 - c. A field functional acceptance test shall be made of the entire system, including instruments, controls, alarms, plant control system, control strategy, motors, VFDs, and valves, to ensure compliance with the performance specified herein.
6. In the event any system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.
7. After each equipment 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 tests, a listing of all persons present during the tests, and the test data.

D. Performance Testing

1. Where required by the individual equipment sections, each system shall be performance tested, after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings. The performance of each equipment, motor, and VFD shall be verified.
2. All expenses for conducting the performance testing shall be paid by the **CONTRACTOR**. All equipment and instrumentation required for the testing shall be provided by the Contractor.

3. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. Contractor shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by Contractor until this equipment has been tested by the Contractor and the results of these tests are satisfactory to the Engineer or his designated representative.
4. Performance testing will be witnessed by the Engineer. The Contractor shall give notice to the Owner/Engineer 2 weeks prior to the scheduled test date.
5. At least 2 weeks prior to performance test, Contractor shall submit for review and approval a copy of the proposed performance test procedure.
6. The following performance testing shall be conducted:
 - a. Startup, check, and operate the system over its entire speed range. Vibration shall be within the amplitude limits recommended by the specified Standards over the range of operating conditions defined by the Engineer.
 - b. Obtain concurrent readings of motor voltage, amperage, for at least four operating conditions. Check each power lead to the motor for proper current balance.
 - c. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
7. The tests shall demonstrate that the equipment has been properly installed, aligned and connected, is free of mechanical defects, electrical defects, excessive vibration, overheating or overloading, and that the control system performs as specified and meets all operating criteria. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period. If any part of a unit shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made by the Contractor and the full performance test shall be redone for that unit after all parts operate satisfactorily.
8. 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 tests, a listing of all persons present during the tests, and the test data.

3.4 COUPLINGS

- A. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application; installation shall be per equipment manufacturer's printed recommendations.

3.5 INSULATING CONNECTIONS

- A. All insulating connections shall be installed in accordance with the manufacturer's printed instructions.

3.6 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. Hangers, supports, and guides shall be spaced in accordance with ANSI/ASME B.31.1 standard, and with tables in Section 15006 - Pipe Supports.

3.7 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate all necessary space and structural requirements, clearances, utility connections, signals, and outputs with his subcontractors, to avoid later change orders.
- B. If the packaged system has any additional features (as safety interlocks, etc.), other than specified, the Contractor shall coordinate such features with the Engineer and furnish all material and labor necessary for a complete installation as required by the manufacturer, at no additional cost to the Owner.

END OF SECTION

SECTION 11052 – AUTOMATIC REFRIGERATED SAMPLERS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one (1) automatic sampling unit including automatic wastewater sampler, refrigerated sample collector, and sampling chamber and all necessary piping, pumps, connections, controls, mounts, valves, motors, and appurtenances for a complete and operable installation, in accordance with the requirements of the Contract Documents, in particular Section 11000, Equipment General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11000 Equipment General apply to the work of this Section.

NEMA 250-1997

Enclosures for Electrical Equipment

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 Submittals, CONTRACTOR shall submit the following:
 - 1. Make, model, weight and horsepower of each unit
 - 2. MANUFACTURER's catalog information, descriptive literature, specifications, and identifications of materials of construction.
 - 3. Detailed Drawings: Structural, mechanical, and electrical, showing equipment fabrications and interface with other items including dimension, size, and locations of connections to other work, and weights of associated equipment.
 - 4. External utility requirements such as water, power, drains, etc.
 - 5. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled or alarmed.
 - 6. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
 - 7. Power and control wiring diagrams, including terminals and numbers.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Certifications: The CONTRACTOR shall obtain written certification from the MANUFACTURER, addressed to the OWNER, stating that the equipment will efficiently and thoroughly performed the required functions in accordance with these Specifications when the specified equipment is intend for outdoor use in a wastewater treatment application.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
- B. Warranty
 - 1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 - 1. 0.5 person-days for installation assistance and inspection,
 - 2. 0.5 person-days for functional and performance testing
 - 3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – HW-EQP1

- A. Each composite sampler/pump shall be a self-contained, factory pre-wired, floor-standing unit with the sampler located above the refrigerated sample collector. The sampler shall be the peristaltic pump type. Each unit shall be mounted in a frame or cabinet that provides a minimum of one inch of clearance between the floor and the bottom of the refrigerated sample collector. Each sampler shall have the capability to adjust sampling mode and frequencies.
- B. If not supplied as one unit, the sampler and refrigerated sample collector shall be securely attached to each other and the assembly of both rigidly attached to the foundation. Each refrigerated collector shall have the capacity to hold a 5-gallon container. The container shall have two carrying handles and fully removable lids for cleaning.

2.2 PERFORMANCE REQUIREMENTS

- A. Sampling Capacity: Each sampler shall be capable of drawing a liquid sample a vertical height of 20 feet through a minimum 3/8-inch inside diameter tube at a rate not less than 1.9 ft/sec through 15 feet of tubing.
- B. Sampling Cycle: Each sampler shall be capable of taking a sample from 10 ml to 9,999 ml per sampling cycle. The sampling cycle shall be initiated by the external flow signal, or from the internal timer, or by the manual switch. After re-purging the suction line, all electrical timers, switches, and valves shall reset to the appropriate settings to begin another sampling cycle.
- C. Refrigerated Collector
 - 1. Reach refrigerated collector shall be capable of maintaining a temperature in the collector compartment between 0 degrees C and 8 degrees C with an ambient outside temperature of 115 degrees F and shall operate on 115 Volt single phase 60-Hz power. The sampler control will automatically shut down when the collector is full.
- D. Sample Pump
 - 1. Sampled fluid shall only contact the sample probe, the sample pump tubing and the sample container.
 - 2. The sample pump shall be peristaltic type having a capacity of at least 3000 ml/minute through 3/8-inch silicone rubber tubing.
 - 3. The peristaltic pump shall air purge the sample line before and after each sample is collected.
 - 4. Purging shall be automatically controlled without adjustment.

2.3 MATERIALS OF CONSTRUCTION

- 1. General: All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects

and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

2. Container: The container shall be constructed of polyethylene plastic or stainless steel, cylinder shaped.
3. Fasteners: All anchor bolts, nuts, and washers shall be 316 stainless steel.
4. Pump Construction: Each pump shall be of the peristaltic type with a capacity, suction lift, and discharge head sufficient for the sampling system of the unit. The pump shall be a peristaltic pump made of reinforced engineering plastic for corrosion resistance.
5. Sample Tube: Each sampler shall be equipped with a length of Dow Corning Silastic Rx50 medical grade tubing suitable for connection with the sampling chamber. Inside diameter of the tubing shall not be less than 3/8-inch. The tubing shall be connected using stainless steel hose clamps. The supply suction tubing from sample point to sampler shall be placed in a 2-inch schedule 80 PVC carrier pipe clamped to the concrete. A strainer will be provided on the suction end of the carrier pipe.
6. Enclosure: Each sampler/controller shall be enclosed in a reinforced fiber glass cabinet with a UV-resistant gel coat and shall be rated NEMA 4 or 6 as needed to comply with hazardous classifications of the environments in which they are installed. The enclosure shall be suitable for an outdoor installation. The cabinet shall contain access doors with locking mechanism. All equipment within the cabinet shall be easily accessible for maintenance.

2.4 CONTROLS

- A. Operating Modes: Each sampler shall be capable of operating in any of the following 3 modes:
 1. Flow proportional basis from an external signal.
 2. Time proportional basis from an internal timer.
 3. Manual basis by activation of a switch on the sampler.
- B. Control: The sampler shall accept an external 4-20 mA flow signal, and shall convert the signal as required within the sampler. The sampler shall be capable of operation from the flow signal. The sampler shall not load the analog loop in excess of 250 ohms.
- C. Timer: The internal timers shall be capable of initiating the sampling sequence after a preset time has elapsed. This preset time shall be variable from 4 minutes to minimum 12 hours.
- D. Status Monitoring: Each sampler shall be provided with a dry set of electrical contacts for operational status monitoring, closing at the start of the sampling sequence, and remaining closed until the entire sampling sequence has been completed. The electrical contacts shall be rated no less than 5-amps at 24 volts dc and 120 V-60 Hz.
- E. Controls shall be supplied per Section 13400 Instrumentation and Control System and Section 13475 Control Strategies.

2.5 MOTOR

- A. Pump Motor: Each motor shall be 1800 rpm, TEFC and shall not be overloaded when the pump is operated at any point on the H/Q curve within the recommended operating range of the pump.
- B. Pump Power Supply: Each pump shall operate on 115-volt, single-phase, 60-Hz power, and it shall be supplied with a waterproof electrical junction box attached to the exterior for electrical connections for power and signals.
- C. Motors shall be in accordance with Section 16222 Motors.

2.6 SPARE PARTS

- A. Spare Parts: Each sampler shall be furnished with one year's supply of the MANUFACTURER's suggested spare parts and any other elements subject to wear or frequent replacement. All parts shall be properly labeled and identified with the name and number of the equipment to which they belong. The CONTACTOR shall furnish 100 feet of 3/8" ID Teflon tubing for sample tubing replacement.

2.7 PROTECTIVE COATING

- A. General: Protective coating of samplers shall conform to the requirements of this Section. All other equipment shall be coated in accordance with the requirements of Section 09960, Protective Coatings.
- B. Surface Preparation: All steel surfaces of samplers and refrigerated sample collectors shall be blast cleaned in the shop to a commercial blast cleaned surface conforming to SSPC-SP-6. All dust shall be removed prior to coating. Surfaces shall be coated the same day sandblasting is performed.
- C. Protective Coating: All steel surfaces of samplers, refrigerated sample collectors and supporting framework, if any, shall be shop coated with a baked epoxy powder coating to a minimum dry film thickness of 12 mils. Powder coating shall be applied by the fluidized bed or electrostatic spray method by qualified, experienced personnel. Oven curing shall conform to the recommendations of the epoxy powder MANUFACTURER. Interior surfaces of samplers and sample collectors shall be white. The exterior color shall be as directed by the ENGINEER.
- D. The CONTRACTOR is cautioned to use care during installation to avoid damage to the protective coatings on this equipment. If the coating is damaged during installation, the CONTRACTOR will be required to return the equipment to the MANUFACTURER for recoating. Field touchup will not be acceptable.

2.8 MANUFACTURERS

- A. MANUFACTURER's Experience: MANUFACTURERS shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufactures specializing in the manufacture of such products. The MANUFACTURER's Qualifications covered in this Section shall be submitted to the ENGINEER.

- B. Unit Responsibility: A single MANUFACTURER shall be made responsible for furnishing the WORK and for coordination of design, assembly, testing, and installation of the WORK of each composite sampler system; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of the contract documents.
- C. Manufacturers or Equal:
 - 1. Hach (Sigma).
 - 2. Teledyne (Isco).

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.
- B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage.
- C. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, 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.

3.3 TESTING

- A. Field Tests
 - 1. Upon completion of the installation, each piece of equipment and each system shall be field-tested for satisfactory operation without excessive noise, vibration, overheating, etc. All equipment must be adjusted and checked for misalignment, clearances, supports, and adherence to safety standards.
 - 2. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

3. The CONTRACTOR shall bear 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.

B. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01650 Facility Startup.

END OF SECTION

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SECTION 11100 – PUMPS, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all pumps, motors and pumping appurtenances, complete and operable, in accordance with the Contract Documents. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/IEEE 115	Test Procedure for Synchronous Machines
ANSI/HI 1.6	American National Standard for Centrifugal Pump Tests
ANSI/HI 2.6	American National Standard for Vertical Pump Tests

- A. The requirements of Section 11000 – Equipment, General are applicable to this section.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300, CONTRACTOR shall submit the following:
 - 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. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided 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. Data, in accordance with Section 16222 –Motors, for the electric motor proposed for each pump.
 6. 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.
 7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
 8. Complete electrical schematic diagram.
 9. Torsional Analysis
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data. Prior to start up the CONTRACTOR shall furnish six copies of the Operations and Maintenance Manuals for each pump Section.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Quality Assurance: CONTRACTOR shall submit the following:
1. Manufacturer's Certificate of Proper Installation
 2. Functional and Performance Test Results and Certifications
 3. Factory performance test reports:
 - a. Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.
 4. Special shipping, storage and protection, and handling instructions
 5. Manufacturer's printed installation instructions
 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance. Spare Parts List shall contain the furnished spare parts for each pump Section.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
8. Certified pump performance curves for each pump section signed by officer of manufacturer. Certification to include manufactures guarantee performance of flow, head, and efficiency at specified conditions.
9. The CONTRACTOR shall obtain and submit written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the designated single manufacturer accepts the CONTRACTOR'S assignment of full responsibility for coordination of all equipment, including operators and controls, and services required for proper installation and operation. The CONTRACTOR shall submit all such certificates to the ENGINEER.

1.4 QUALITY ASSURANCE

- A. Fabrication, delivery, and installation shall be in accordance with applicable Hydraulic Institute Standards and requirements.
- B. Pumps are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.
- C. Warranty
 1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section – 01740 Warranty.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed in the individual pump sections, travel time excluded.
- B. Inspection, installation assistance, functional and performance testing: Where required by the individual pump Sections, an authorized service representative of the manufacturer shall visit the site for the time 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 functional and performance testing for proper operation.
 4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.
- C. Pre-startup training 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 time 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 two years of experience in training. A resume for the representative shall be submitted.
 3. Training shall be scheduled as specified in Section 01730, Operation and Maintenance Data.
 4. Proposed training material and a detailed outline of each lesson shall be submitted for review as specified in Section 01730, Operation and Maintenance Data. 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.
- D. A work day is defined as an eight hour period at the site, excluding travel time.
- E. The ENGINEER may require that the inspection, startup, and field adjustment and train services to be furnished over separate trips for each pump Section as specified in each pump Section.

PART 2 PRODUCTS

2.1 GENERAL

- A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the manufacturer's standard equipment.
- B. 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.
- C. Performance Curves: All centrifugal pump curves shall be continuously rising from maximum flow to the shutoff.

2.2 PUMP SCHEDULE

PUMP NO.	NAME	LOCATION	PROCESS FLUID	PUMP TYPE
GRT-PMP1	Grit Pump No. 1	Headworks	Grit	Recessed Impeller
GRT-PMP2	Grit Pump No. 2	Headworks	Grit	Recessed Impeller
EQ-PMP1	Equalization Return Pump No. 1	Equalization Basin	Primary Influent and Effluent	Self-Priming

PUMP NO.	NAME	LOCATION	PROCESS FLUID	PUMP TYPE
EQ-PMP2	Equalization Return Pump No. 2	Equalization Basin	Primary Influent and Effluent	Self-Priming
PC2-PMP1	Primary Sludge/Scum Pump No. 1	Primary Clarifier #2	Primary Sludge/Scum	Double Disc
PC2-PMP2	Primary Sludge/Scum Pump No. 2	Primary Clarifier #2	Primary Sludge/Scum	Double Disc
FFR-PMP1	FFR Feed Pump No. 1	Fixed Film Reactor	Primary Effluent	Vertical Non-Clog
FFR-PMP2	FFR Feed Pump No. 2	Fixed Film Reactors	Primary Effluent	Vertical Non-Clog
FFR-PMP3	FFR Feed Pump No. 3	Fixed Film Reactors	Primary Effluent	Vertical Non-Clog
FIL-PMP1	Filter Feed Pump No. 1	Disc Filters	Secondary Effluent	Submersible
FIL-PMP2	Filter Feed Pump No. 2	Disc Filters	Secondary Effluent	Submersible
FIL-PMP3	Filter Feed Pump No. 3	Disc Filters	Secondary Effluent	Submersible
FIL1-PMP1	Filter 1 Backwash Pump No. 1	Disc Filter No. 1	Disc Filter Backwash	Self-Priming End Suction Centrifugal (provided as part of Filter Package)
FIL1-PMP2	Filter 1 Backwash Pump No. 2	Disc Filter No. 1	Disc Filter Backwash (provided as part of Filter Package)	Self-Priming End Suction Centrifugal (provided as part of Filter Package)
FIL2-PMP1	Filter 2 Backwash Pump No. 1	Disc Filter No. 2	Disc Filter Backwash (provided as part of Filter Package)	Self-Priming End Suction Centrifugal (provided as part of Filter Package)
FIL2-PMP2	Filter 2 Backwash Pump No. 2	Disc Filter No. 2	Disc Filter Backwash (provided as part of Filter Package)	Self-Priming End Suction Centrifugal (provided as part of Filter Package)
FC-PMP1	Ferric Chloride Pump	Existing pump to be removed and reinstalled in the Ferric Chloride area	Ferric Chloride	Peristaltic
UW-PMP1	Utility Water Pump	Chlorine Contact Tanks	Treated Plant Effluent	Self-priming
UW-PMP2	Utility Water Pump	Chlorine Contact Tanks	Treated Plant Effluent	Self-priming

PUMP NO.	NAME	LOCATION	PROCESS FLUID	PUMP TYPE
UW-PMP3	Utility Water Pump	Chlorine Contact Tanks	Treated Plant Effluent	Self-priming
SMP-PMP5	Sample Pump No. 5	Existing pump to be removed and relocated adjacent to Utility Water Pumps	Treated Plant Effluent	Self-Priming End Suction Centrifugal
R-PMP1	Recycle Pump No. 1	Recycle Wet Well	Plant Drainage	Submersible
R-PMP2	Recycle Pump No. 2	Recycle Wet Well	Plant Drainage	Submersible

2.3 PUMP COMPONENTS

- A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:
- B. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A48 - Gray Iron Castings, Class 30, or equal.
- C. Bronze pump impellers shall conform to ASTM B62 - Composition Bronze or Ounce Metal Castings, or B584 - Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
- D. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316, except in a septic environment.
- E. Anchor bolts, washers, and nuts in Standard Service (Non-Corrosive Application) shall be galvanized steel in accordance with the requirements of Section 05500 – Miscellaneous Metals. Anchor bolts, washers, and nuts in Corrosive Service as defined in Section 05500 shall be stainless steel in accordance with that Section.
- F. Flanges: 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 B16.5 - Pipe Flanges and Flanged Fittings dimensions.
- G. 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 lineshafts. Pumps for sewage, sludge, and other process fluids shall be lubricated as indicated.
- H. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.
- I. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

- J. 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.
- K. 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.
- L. Stuffing Boxes: Where stuffing boxes are specified 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 flushed as shown on the drawings, using lantern rings.
 - 1. Unless otherwise indicated, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
 - 2. Shaft Speeds: Up to 2,500 fpm.
 - 3. Temperature: Up to 500 degrees F.
 - 4. pH Range: 0-14.
 - 5. If fresh water is not available, the seal shall be flushed with utility water from the plant's utility water system.
- M. Mechanical Seals: Mechanical seals shall be flushed as indicated in the contract drawings.
 - 1. Mechanical seals shall be as manufactured by the following, unless indicated differently in the individual pump sections, in which case seals shall be as indicated in the individual pump sections:
 - 1) Chesterton mechanical split cartridge type, Chesterton 442.
 - 2) John Crane mechanical split cartridge type, John Crane 3710
 - 2. 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.
 - 3. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.
 - 4. A seal water flush system shall be provided for flushing mechanical seals. The CONTRACTOR is responsible for coordinating and furnishing and installing a system, complete and self-contained to the pump, with connections to the mechanical seal housing, including an isolation valve and other appurtenances as indicated in the Drawings.
- N. Pump appurtenances

1. 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.
2. Solenoid Valves: The pump manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.
3. Gages:
 - a. All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gages installed at pump discharge lines. Pump suction lines shall be provided with compound gages. Gages shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
 - b. Where subject to shock or vibrations, the gages shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
 - c. Pressure and compound gages shall be provided in accordance with Section 13400 – Instrumentation and Control Systems.

2.4 MOTORS

- A. Unless otherwise indicated in the individual pump sections, each pump shall be provided with a Series 400 stainless steel vertical, solid shaft; premium, high thrust, TEFC enclosure, 460 volt, 3-phase, 60 Hertz heavy duty, electric motor in accordance with Section 16222, Electric Motors.
- B. Variable speed drives shall be provided as specified in each pump section and in accordance with Section 16222 - Motors. The variable frequency drive controller and components shall be housed as shown on the Drawings and specified in each pump Section. Pump Supplier shall coordinate with VFD Supplier to ensure pump and VFD compatibility.

2.5 SPARE PARTS

- A. Spare parts shall be provided as indicated in the individual pump sections.
- B. The pumps shall be backed by supplies of spare parts from stock, and after-sales service from a factory trained and authorize maintenance facility, located within 500 miles from the installation.
- C. All spare parts shall be accompanied by a packing list and be in a condition acceptable to the ENGINEER or his designated representative. The packing list shall include a detailed listing of each item, including name of equipment, referenced Specification Section and subsection, name of part, manufacturer's name, and cost of item. All spare parts shall be delivered and stored as indicated in Section 01600 – Delivery Storage and Handling.

2.6 PROTECTIVE COATING

- A. General: Materials and equipment shall be coated in accordance with Section 09960 – Protective Coatings and the Contract Documents.

- B. Shop Coating. After shop testing and before shipment, all ferrous surfaces, excluding machined surfaces and nameplates, shall be shop painted.
- C. Field Coating. Field coating shall not be executed until after field testing is completed. Additionally, machined surfaces and nameplates shall not be painted. Color shall be approved by ENGINEER.

2.7 MANUFACTURERS

- A. Manufacturer Experience: Manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract. All manufactured items provided under this Section shall be new, or current manufacture, and shall be the products of reputable manufactures specializing in the manufacture of such products. The Manufacturer's Qualifications covered in this Section shall be submitted to the ENGINEER.
- B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the pump. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.
- B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.
- C. Equipment furnished shall be shipped to the site in enclosed, weather-tight, sealed containers in a manner designed to protect the pumping units against damaging stress caused by sudden acceleration or deceleration. For equipment 25 horsepower or greater, two recording accelerometers, designed to record the magnitude of any sudden impact in all three directions (X, Y, Z) on continuous strip charts, shall be shipped with, and fixed to each assembly or its packing container. Upon arrival of each shipment, the accelerometers shall be removed in the presence of representatives of the ENGINEER, the CONTRACTOR, and the equipment manufacturer. If magnitude of the maximum acceleration exceeds 3.0 times the acceleration due to the force of gravity (3.0 g), the assembly or subassembly shall be dismantled and completely inspected. All damage shall be corrected to the complete satisfaction of the ENGINEER before the assembly is incorporated in to the work. The CONTRACTOR shall bear all costs arising out of dismantling, inspection, repair, and reassembly.

- D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to project through the box or crate so that attachment to the hoisting equipment can be readily made.
- E. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
- F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.
- G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.
- H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.
- I. Each pump shall be properly crated to protect the units against damage during shipment.

3.2 INSTALLATION

- A. Install in accordance with the manufacturer's printed instructions.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, 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. Pump Alignment to be performed by CONTRACTOR.
- C. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation for a period of at least one year.
- D. The CONTRACTOR shall accomplish pump installation with assistance from the pump Manufacturer.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650 Facility Startup.
- B. Factory Testing
 - 1. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.

2. The following tests shall be conducted on each indicated pump system:
 - a. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
 - b. Pump Systems: All pump systems shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute. Tests shall be performed using the complete pump system to be furnished, including the motor. For motors smaller than 100 hp, the manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
 - 1) Hydrostatic test data.
 - 2) 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.
 - 3) Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
 - 4) Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
 - c. Factory Witnessed Tests: All pumps and motors 125 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. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed test procedure. All costs for OWNER and ENGINEER shall be borne by the OWNER. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER.
 - d. 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 at no additional cost to the OWNER until found satisfactory.

C. Installation Functional Testing

1. The CONTRACTOR shall bear all costs of the functional 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 functional testing. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.
2. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall

supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.

3. Functional testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ ENGINEER two weeks prior to the scheduled functional field test date.
4. At least 2 weeks prior to the test, CONTRACTOR shall submit for review and approval a copy of the proposed functional test procedure.
5. The following functional testing shall be conducted:
 - a. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is specified.
 - b. The pumping station shall operate as described under the control strategy outlined in the instrumentation specification.
 - c. A field functional acceptance test shall be made of the entire pumping system, including instruments, controls, alarms, plant control system, control strategy, motors, new pumps, VFDs, existing pumps, and valves, to ensure compliance with the performance specified herein.
6. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.
7. After each pumping system has satisfied the requirements, the CONTRACTOR and Factory Representative 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 tests, a listing of all persons present during the tests, and the test data.

D. Operation Performance Testing

1. Where required by the individual pump sections, each pump system shall be performance tested, after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings. The performance of each pump, motor, and VFD shall be verified.
2. All expenses for conducting the performance testing shall be paid by the CONTRACTOR. All equipment and instrumentation required for the testing shall be provided by the CONTRACTOR.
3. The final adjustments and inspections shall be made by factory-trained and authorized service personnel other than sales representatives, who also shall supervise the installation and test operation. CONTRACTOR shall include in bid, allowance for factory-trained service personnel to adjust all of the said equipment to be installed by CONTRACTOR until this equipment has been tested by the CONTRACTOR and the results of these tests are satisfactory to the ENGINEER or his designated representative.

4. Performance testing will be witnessed by the ENGINEER. The CONTRACTOR shall give notice to the OWNER/ENGINEER 2 (two) prior to the scheduled test date.
5. At least 2 weeks prior to performance test, CONTRACTOR shall submit for review and approval a copy of the proposed performance test procedure.
6. The following performance testing shall be conducted:
 - a. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
 - b. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
 - c. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
7. The tests shall demonstrate that the equipment has been properly installed, aligned and connected, is free of mechanical defects, electrical defects, excessive vibration, overheating or overloading, and that the control system performs as specified and meets all operating criteria. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period. If any part of a unit shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made by the CONTRACTOR and the full performance test shall be redone for that unit after all parts operate satisfactorily.
8. 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 tests, a listing of all persons present during the tests, and the test data.

E. Operational Testing

1. Provide testing in accordance with Section 01650 Facility Startup.

END OF SECTION

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SECTION 11136 – VERTICAL NON-CLOG PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install three (3) vertical non-clog pumps, with electric motors and all appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents.
- B. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump that will satisfy the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: The CONTRACTOR shall provide submittals according to the requirements of Section 11100 Pumps General.
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative.** In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 1 person-days for functional and performance testing
3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – FFR-PMP1, FFR-PMP2, FFR-PMP3

- A.** The pumping units shall be heavy duty, vertical dry pit, single suction, centrifugal solids handling pumps for wastewater service.
- B.** Forward rotation of the impellers shall be counterclockwise when the pump is viewed from the top.

2.2 PERFORMANCE REQUIREMENTS

- A.** Refer to the Pump Data Sheet at the end of this section for performance requirements.

2.3 MATERIALS OF CONSTRUCTION

- A. Pump Construction:** Construction of vertical non-clog pumps shall conform to the following requirements:
1. **Suction and Discharge:** Suction and discharge connections shall be flanged. The suction elbow shall be the same material as the casing and shall be provided with a large handhole and bolt-on handhole cover, contoured to match the suction interior, sufficiently close to the impeller to permit inspection of and measuring of the wearing ring gap with a feeler gauge. The handhole opening shall be larger than the maximum size solid the impeller can pass. It shall also be provided with a 2-inch minimum threaded drain connection with a ball valve (by Contractor) for controlled draining. Half-inch taps shall be provided for suction and discharge pressure gauges. The suction head shall be ASTM A48 or ASTM A278, Class 35

cast-iron containing 2 to 3 percent nickel. Suction head shall have four tapped connections for wearing ring flushing water, which shall be plugged for future use. Taps shall not extend through suction wearing ring. Furnish foundry certification of ASTM number, tensile strength and percent nickel added.

2. Casing: Pump casing shall be in accordance with the following:
 - a. The casing shall be a 1-piece volute design with integral discharge flange and ribs. Pumps supported only from the suction piping shall not be acceptable.
 - b. Twin or double casings are not acceptable.
 - c. The casing shall be ASTM A48 or ASTM A278, Class 35 cast iron containing 2 to 3 percent nickel and have hand holes and bolted-on hand hole covers, having the interior surfaces match the casing contour. The mounting feet and other features shall not interfere with easy access to hand holes, bolts, or drain and vent piping.
 - d. The casing shall be hydrostatically tested for 4 hours at 150 percent of design point head or 125 percent of shut-off head, whichever is greater. Volute shall have smooth fluid passages, large enough at all points to pass any size solid that can pass through the impeller and provide smooth, unobstructed flow. Three lifting eyes shall be provided in the casing for convenience in handling the pump. The casing shall be designed and constructed so that all rotating parts may be removed, by removing only one ring of bolts, and without disturbing the suction or discharge piping. A 1-inch drilled and tapped hole with ball valve shall be provided on top of the casing to vent air.
 - e. Provide material certification of ASTM number, tensile strength and percent nickel added.
3. Impeller: The impeller shall be a single-stage, single suction, 1 -piece, enclosed type. Material for the impeller shall be ASTM A48 or A278, Class 35 cast iron containing 2 to 3 percent nickel. The impeller shall be finished so that all surfaces are smooth. All passages which will be in contact with sewage shall be free from hollows, pinholes, cracks, and projections that might cause cavitation or pitting. The impeller shall be statically and dynamically balanced with wearing ring attached. The impeller shall be secured to the pump shaft by stainless steel bolt and contoured washer. The arrangement shall be such that the impeller cannot be loosened by forward or reverse rotation torque. The impeller shall be designed to pass solid spheres up to size specified above. Provide material certification of ASTM number, tensile strength and percent nickel added.
4. Wear Rings: Removable wearing rings of the axial type design shall be provided for the impeller and for the suction heads. The impeller wearing ring shall be stainless steel meeting ASTM A743-CA-15 with a minimum Brinell Hardness of 350. The suction wearing ring shall be ASTM A743-CA-40 and at least 50 points harder than impeller wearing ring. Wearing rings shall be fastened with stainless steel countersunk locking screws. The clearances between the wearing rings shall be such as to prevent leakage and reduce wear to a minimum. Wear rings shall provide for a minimum of 1/4-inch wear before replacement is required.
5. Mechanical Seal: The pumps shall be supplied with a single cartridge-type mechanical shaft seal. No external flush will be provided for these seals. The O-rings shall be static. The rotating face shall be driven by a pin. All metal parts shall be Type 316 stainless steel except for springs which shall be Elgiloy. All rubber parts shall be Viton. The rotating face shall be tungsten carbide. The

stationary face shall be silicon carbide. The seal supplier shall also supply a bronze SpiralTrac bushing for the stuffing box.

6. Pump Shaft and Sleeve: The shaft to which the impeller is attached shall be ASTM A576, 1045 heat treated alloy steel. The shaft shall be accurately machined and ground over its entire length, and shall be of ample strength and stiffness to operate without distortion or vibration over the full operating range. The shaft shall be sized to limit deflection at the stuffing box to 0.002-inch under any operating condition. Where the shaft passes through the stuffing box, a renewable shaft sleeve shall be provided. The shaft sleeve shall be 316 stainless steel. The sleeve shall be removable, but locked in place to prevent relative rotation and sealed to prevent leakage between shaft and sleeve. The materials, tolerances, and finish of the shaft and sleeve shall be coordinated with the seal supplier. Critical speeds for the shaft shall be:
 - a. First critical speed shall be at least 15 percent above the maximum speed and shall not coincide with vane pass and two times vane pass at any operating speed.
 - b. Second critical speed shall be at least 25 percent above the maximum operating speed and shall not coincide with vane pass and two times vane pass at any operating speed.
7. Bearing Frame and Backhead: The backhead shall be ASTM A48 or ASTM A278, Class 35 cast iron. The backhead shall be cast in 1-piece and be provided with an integral NPT drain connection for stuffing box leakage. The backhead shall support the bearing frame. The bearing frame shall be provided with coded shims and jacking bolts to allow maintenance of the wearing ring gap. The bearing frame assembly shall be designed to withstand the loads from running against a closed valve on the pump discharge.
8. Bearings: Bearings shall be anti-friction type bearings and be capable of supporting all weights and radial play imposed under continuous service without overheating. The bearings shall be grease lubricated. Bearings shall have a minimum B-10 life of not less than 100,000 hours at the full speed run-out condition. The bearing housing shall be provided with seals to retain lubricant and prevent the entrance of foreign matter. Bearing temperature rise over the ambient shall not exceed 32 degrees C, as measured on the surface of the bearing frame. Each bearing housing shall include taps for temperature and vibration monitoring. Bearings shall be designed to eliminate all radial and axial movement.

2.4 CONTROLS

1. Pump controls shall be supplied per Section 13400 Instrumentation and Controls and Section 13475 Control Strategies.

2.5 MOTOR

- A. The requirements of Section 11100 – Pumps, General, apply to this section.
- B. Pump motor shall be as required in the Supplemental Pump Data Sheet.
- A. Each pump shall be driven by an existing variable frequency drive. Contractor shall coordinate between the pump and drive manufacturers/suppliers to ensure compatibility.

2.6 SPARE PARTS

- A. 1 set special tools (as required for pumping unit disassembly)
- B. The following spare parts shall be provided with each pump:
 - 1. 3 sets of all gaskets and O-rings
 - 2. 3 sets of all wear rings
 - 3. 3 sets of all pump shaft bearings
 - 4. 3 sets of mechanical seals
 - 5. 3 sets of shaft sleeves, keys, nuts and accessories
 - 6. 1 set of special tools (as required for pumping unit disassembly)

2.7 PROTECTIVE COATING

- 1. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.8 MANUFACTURERS

- A. The pump manufacturer shall have a minimum of 1,000 heavy-duty vertical non-clog pumps of similar size and service installed and operating for no less than five years in the United States.
- B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the pump. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.
- C. Manufacturers or Approved Equal:
 - 1. Fairbanks Morse.
 - 2. Patterson.
 - 3. Flowserve.
 - 4. Yeomans (Grundfos)

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Refer to Section 11100 Pumps General for delivery and storage requirements.

3.2 INSTALLATION

- A. Refer to Section 11100 Pumps General for installation requirements.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650, Facility Startup. All pump testing shall be in accordance with Section 11100 Pumps General.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are part of this Specification.
 - 1. Pump Data Sheet

END OF SECTION

**PUMP DATA SHEET
VERTICAL NON-CLOG PUMPS
PUMPS NO. FFR-PMP1, FFR-PMP2, FFR-PMP3**

Project:	Treatment and Wet Weather Upgrade Project	Manufacturers	
Owner:	Sausalito Marin-City Sanitation District	A.	Fairbanks Morse
Service:	Secondary Effluent	B.	Flowserve
Pump Name:	Fixed Film Reactor Pumps	C.	Patterson
Eqpt. Tag Nos.	FFR-PMP1, FFR-PMP2, FFR-PMP3		Or Equal
Quantity:	Three (3)		
Operating Conditions		Service Conditions	
Liquid Temperature °F	Normal: Max: Min:	Ambient Temperature (°F)	Normal: 67° Max: 100° Min: 30°
Specific Gravity	1.0 at 60 °F	Altitude (ft)	Sea Level
Vapor Pressure(psia)		Environment	Outdoors
Viscosity at 25 °C		Relative Humidity	40% - 100%
pH		Duty	Continuous
Performance Requirements			
	Design Point 1	Design Point 2	Design Point 3
Design Flow Capacity (gpm), Normal	3125	0	3750
Design Pump Head, TDH (ft)	62	119	45
Minimum Efficiency (%)	80	-	70
Minimum NPSH Available (ft)	25	30	23
Maximum Pump Speed (rpm)	1185	1185	1185
Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	10	75	Vertical
Discharge	8	75	Horizontal
Seal Type	Mechanical		
Motor Data			
Min. Motor Horsepower:	75	Voltage:	460
Speed (rpm):	1200	Phase:	3
Enclosure Type:	TEFC	Service Factor at rated max. ambient temperature:	1.15
Mounting Type	Vertical		
Drive Type	VFD. Operating Speed Range: 100 to 50% of Rated Speed.		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
Note			

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SECTION 11141 – RECESSED IMPELLER PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install two (2) recessed impeller pumps, with electric motors and all appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents.
- B. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump that will satisfy the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A532 Abrasion-Resistant Cast Irons

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: The CONTRACTOR shall provide submittals according to the requirements of Section 11100 Pumps General.
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.

7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 1 person-days for functional and performance testing
3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – GRT-PMP1, GRT-PMP2

- A. Equipment should be in conformance with Section 11100 Pumps General.

2.2 PERFORMANCE REQUIREMENTS

- A. Refer to the Pump Data Sheet at the end of this section for performance requirements.

2.3 MATERIALS OF CONSTRUCTION

- A. Construction of horizontal recessed impeller pumps shall conform to the following requirements (no cast iron or steel are to be in contact with the pumped fluid):

Casing	Type A Hi-chrome iron, ASTM A532 Class III, two-piece, heavy duty construction with removable and replaceable suction cover and backplate, minimum 650 Brinell hardness.
Impeller	Hi-chrome fully recessed, cupped type, minimum 650 Brinell hardness, statically and dynamically balanced.
Backing Plate (where used)	Cast Iron
Wear Plate	Same as casing
Shaft	1045 alloy steel
Shaft Sleeve	Type 316 stainless steel, removable
Bearings	Radial and thrust, roller or deep groove angular

contact ball bearings, 100,000 hours L-10 life, oil or grease lubricated

Seal	Cartridge-type non flushed single mechanical seal with silicon carbide vs tungsten carbide faces
Pump Base	Cast-iron or fabricated steel
Belts	Multiple V-belts
Belt Guard	Galvanized steel or fiberglass – OSHA approved
Sheaves	Multiple groove constant diameter pump sheave and stationary variable speed (SVS) adjustable pitch motor sheave

- B. After installation and startup, the grit pumps shall be tested to determine flow. The CONTRACTOR shall test the grit pumps using a strap-on ultrasonic flow meter. Based on the flow test, the SVS motor sheave pitch diameter shall be adjusted to obtain the desired flow.

2.4 CONTROLS

1. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.

2.5 MOTOR

- A. Motor shall be a horizontal, heavy-duty, electric motor suitable for 460-volt, 3-phase, 60-Hz ac power supply. The motor shall be supported from the pump base.

2.6 SPARE PARTS

- A. One spare pump without the motor assembly shall be provided.
- B. The following spare parts shall be provided with each pump:
1. 2 sets of all gaskets and O-rings
 2. 2 sets of all bearings
 3. 2 sets of mechanical seals
 4. 2 sets of wear plates

2.7 PROTECTIVE COATING

1. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.8 MANUFACTURERS

- A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated

successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized grit pumps for a minimum of 10 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.

- B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the pump. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.
- C. Manufacturers or Equal:
 - 1. Wemco, Model C
 - 2. Morris, Model 6100
 - 3. Smith and Loveless,

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Refer to Section 11100 Pumps General for delivery and storage requirements.

3.2 INSTALLATION

- A. Refer to Section 11100 Pumps General for installation requirements.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650 Facility Startup. All pump testing shall be in accordance with Section 11100 Pumps General.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are part of this Specification.
 - 1. Grit Pumps Data Sheet

END OF SECTION

**PUMP DATA SHEET
RECESSED IMPELLER PUMPS
PUMPS NO. GRT-PMP1, GRT-PMP2**

Project:	Treatment and Wet Weather Upgrade Project		Manufacturers	
Owner:	Sausalito Marin-City Sanitation District		A.	Wemco
Service:	Grit		B.	Morris
Pump Name:	Grit Pumps		C.	Smith & Loveless
Eqpt. Tag Nos.	GRT-PMP1, GRT-PMP2			Or Equal
Quantity:	Two (2)			
Operating Conditions			Service Conditions	
Liquid Temperature °F	Normal: Max: Min:	Ambient Temperature (°F)	Normal: 67° Max: 100° Min: 30°	
Specific Gravity	1.1 at 60 °F	Altitude (ft)	Sea Level	
Vapor Pressure(psia)		Environment	Outdoors	
Viscosity at 25 °C		Relative Humidity	40% - 100%	
pH		Duty	Continuous	
Performance Requirements				
	Design Point 1	Design Point 2		
Design Flow Capacity (gpm), Normal	250	0		
Design Pump Head, TDH (ft)	21	28		
Minimum Efficiency (%)	44	-		
Minimum NPSH Available (ft)	55	55		
Maximum Pump Speed (rpm)	820	820		
Pump Construction Details				
	Size, inch	Rating, psi	Location	
Suction	3	150	Horizontal	
Discharge	3	150	Vertical	
Seal Type	Cartridge-type non-flushed single mechanical seal.			
Motor Data				
Motor Horsepower:	7.5	Voltage:	460	
Speed (rpm):	1700	Phase:	3	
Enclosure Type:	TEFC	Service Factor at rated max. ambient temperature:	1.15	
Mounting Type	Horizontal			
Drive Type	Belt			
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer				
Note	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark			

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SECTION 11147 – DOUBLE DISC SLUDGE PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide double disc pumps and motors with associated piping, controls, wiring, and appurtenances, including v-belt drive arrangement, and motor all completely assembled on fabricated stainless steel base and shall conform to the specification section described herein.
- B. The Manufacturer shall review the site conditions, intended application, and operation of the pump system and confirm that the recommended pump will satisfied the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished as required in this Section and in referenced Sections.
- B. Shop Drawings: Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, drive unit, parts, and devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the requirements of Section 01330 Submittals. Detailed specifications of proposed shop-applied coatings and corrosion protection systems for equipment, components, appurtenances, and accessories shall be provided.
- C. Control Diagrams: All proposed control diagrams, installation details, and layouts for all control panels shall be provided.
- D. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- E. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

- F. Contact Information: Contact and pricing information for Suppliers of the double disc pump to be provided. Submit name, address, telephone number, and contact person for the primary equipment Supplier.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:

1. Manufacturer's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

- B. Warranty

1. The equipment shall be warranted for a period of two (2) years from against defects in workmanship and materials under normal use. If the equipment should fail during the warranty period due to a defective part, it shall be replaced and the units restored at no expense to the owner.
2. Unless otherwise specified in this specification section, the equipment shall be provided with a warranty in accordance with Section 01740 – Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. MANUFACTURER's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 0.5 person-days for classroom services,
2. 0.5 person-days for start-up and performance testing

PART 2 PRODUCTS

2.1 GENERAL

- A. Pumps shall be designed to reliably pump liquid and primary sludge and scum mixtures from 0% to 10% solids content.

2.2 PUMP PERFORMANCE REQUIREMENTS

- A. The performance requirements of the double disc pumps are shown in Table 1.

Table 1 - Pump Performance Requirements

Pump tag numbers	PC2-PMP-1, PC2-PMP-2
Number of units	2
Material being pumped	Primary sludge and primary scum
Maximum percent solids	10%
Pump capacity, each (GPM)	100
Rated Discharge Head (Feet)	20
Maximum Discharge Head in Feet	140 ft. head (maximum TDH)
Suction & Discharge Diameter	4 inch
Drive Type	V-belt and pulley arrangement

2.3 PUMP COMPONENTS

- A. Housing: Pump shall be a simplex heavy-duty, double disc, positive displacement type, with Class 30 Cast Iron Housings. Pump shall allow access to the internal components without disturbing the pump bodies, valve chambers, or piping. The discharge housing shall contain mounting lugs and be bolted directly to the mounting frame. The discharge, intermediate and suction housings shall incorporate an integral hinge arrangement that allows the suction and intermediate housing to be lowered and removed. The hinges shall be connected to each other with a quick ball detent pin allowing for easy pin removal.
- B. Discs: Pumping action shall be achieved by two (2) reciprocating discs of Grade 65-45-12 ductile iron attached to high tensile aluminum connecting rods driven by a rotating eccentric shaft. The suction and discharge discs shall be universal and interchangeable with each other for commonality of spare parts. The discs shall be of integral design and constructed of high tensile neoprene with multiple layers of fabric for longevity and strength. Each disc shall be mounted to the connecting rod by a stub shaft constructed of hardened high tensile stainless steel. The reciprocating action of the discs shall also perform the duty of valves. Pumps that require internal check valves for operation shall not be acceptable.
- C. Trunnions: Sealing of the pump fluid chamber shall be achieved by flexible trunnions. The trunnion construction shall be of fabric-reinforced neoprene and shall be capable of withstanding pressures from 0 to 100 psi on an intermittent basis. Pump designs utilizing packing glands, mechanical seals, or water seal system will not be acceptable.
- D. Neck: The swan neck entry port to the suction housing shall be a two (2) piece design allowing for mounting of the suction connection in 90 degree increments and provide easy access for clack replacement. The upper swan neck shall be provided with a 2" NPT connection to allow mounting of the suction pulsation dampener if required. The entry port shall be a full 4" diameter with a minimum opening of 12.56 square inches to minimize debris buildup and blockages. The seating surface for the clack valve shall be

machined on the mounting face of the swan neck. Designs that require an individual plate with smaller diameter opening shall not be acceptable. The clack valve shall be integrally mounted to the swan neck to facilitate access and replacement. The clack valve shall be manufactured of neoprene construction with multiple layers of fabric encapsulating a rigid core. The clack valve shall incorporate an integral O-ring seal for positive sealing

- E. Drive Assembly: The bearing drive assembly shall consist of two (2) aluminum modular pedestals designed to provide accurate bearing alignment, superior bearing loading and ease of assembly. The drive shaft shall be a minimum 1-3/8" diameter and capable of withstanding a dead head situation. The shaft shall be constructed of hardened high-tensile stainless steel and shall be mounted on four (4) self-aligning, sealed bearings. The eccentric cams shall be constructed of high tensile, cast bronze alloy and shall be pinned to the shaft by spirol drive pins to allow for the absorption of reciprocating loads generated by the pumping action. Pump drive assemblies that utilize keyways and setscrews will not be acceptable. All drive bearings must be completely sealed with no provisions for scheduled grease lubrication. No grease fittings shall be supplied for the bearings.
- F. Belt: The pump shall be driven through a V-belt and drive assembly consisting of a 2 groove Type B arrangement. The pulley ratios shall be sized to provide the maximum pump speed listed in the pump schedule in this section and to provide the required torque generated between the pump and motor.
- G. Guards and Covers: Pump shall be provided with OSHA approved guards and covers. The V-belt driver cover and drive assembly cover shall be manufactured from 304SS.
- H. Base: Each pump and V-belt assembly shall be mounted on a common Type 304 stainless steel sub-base. Base design shall have raised cross-members on the suction and discharge end to allow for complete wash-out and draining without trapping liquid. Each sub-base shall be manufactured from 2" Type 304 stainless steel square tubing. Base shall be sufficiently gusseted, reinforced and braced to withstand all shock loads and resist all wearing and buckling during pump operation. Tubing ends shall be capped with black plastic plugs for clean appearance.
- I. Dampeners: Pulsation dampeners shall be provided on the suction and discharge lines. The dampeners shall be 6" diameter Schedule 40 carbon steel pipe with fully welded end caps. The suction dampener shall mount directly to the suction swan neck through the 2" NPT connection. The discharge dampener shall be a separate piece with 4" ASA 150 flanged connections. The dampeners shall be pressure tested to 60 psi for leaks. Each dampener shall be provided with a 1-inch half coupling located at the top. This connection shall be suitable for the vacuum and pressure switch assembly or the ball valve/quick disconnect assembly should a switch not be specified. The discharge dampener shall be supplied with a 1-1/2" NPT coupling and plug in the bottom to act as a drain/sample port. Bladder type and three-piece assemblies using connecting rods and gasket shall not be acceptable.

2.4 CONTROLS

- A. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.

2.5 MOTOR

- A. The motor shall be adequately seized to withstand the loads during startup and pump operation. Motor shall be severe duty, premium efficient, inverter-ready per NEMA STD MG1 Part 31.4.4.2 with epoxy coated cast iron frame. The motor shall be of totally enclosed fan-cooled enclosure designed for continuous operation under full load.
- B. Motor requirements are listed in Table 2 below.

Table 2 - Motor Requirements

Minimum Motor Horsepower	5
Maximum Speed (rpm)	1,800
Voltage	230-460V
Phase	3
Frequency (Hz)	60
Minimum Service Factor	1.15
Motor Enclosure	TEFC

2.6 SUCTION VACUUM PROTECTION

- A. Pump manufacturer shall provide a suction vacuum sensor and switch assembly to mount on the suction pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 (or equal), 1-inch NPT isolation pressure sensor with Type 316 stainless steel body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360- degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with Type 316 stainless steel fittings. The vacuum assembly shall be fitted with 4" stainless steel 30"Hg – 30psi gauge and adjustable vacuum switch set at 10"Hg. The units shall be capable of being cleaned in place by simply using the process pressure through a Type 316 stainless steel isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.7 DISCHARGE PRESSURE PROTECTION

- A. The pump manufacturer shall provide a discharge pressure sensor and switch assembly to mount on the discharge pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 (or equal) 1-inch NPT isolation pressure sensor with 316SS body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360- degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with 316SS fittings. The discharge assembly shall be fitted with a 4" stainless steel 0-100 psi pressure gauge and shall be fitted an adjustable switch preset at 30 psi. The units shall be capable of being cleaned in place by simply using the process pressure through a 316SS isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.8 PROTECTIVE COATINGS

- A. Materials and equipment, unless otherwise stated in this Section, shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.
- B. All ferrous metal surfaces shall be shop cleaned and degreased. All stainless steel and aluminum surfaces will remain unpainted. All weld splatter shall be removed and all welds ground smooth for a clean appearance.

2.9 SPARE PARTS

- A. The following spare parts shall be furnished as a minimum:

Item	Quantity
Discs	2
Trunnions	2
Set of gaskets	2
Control valve	1

2.10 MANUFACTURERS

- 1. Manufacturer, no equal (to match existing equipment):
 - a. Penn Valley Pump Company, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.
- B. Pumps shall be delivered to the jobsite in undamaged condition. Pumps shall be stored above ground and protected from the weather.

3.2 INSTALLATION

- A. Install all items in accordance with the printed instructions of the manufacturer, as indicated as specified.
- B. Dowel to frame after alignment in the field to facilitate realignment after disassembly.
- C. Install and align on a concrete pad as specified in the drawings.
- D. Brace all piping at suction and discharge connections to withstand all shock loads and vibration.

3.3 TESTING

- A. General: Furnish labor, piping, equipment and material for conducting the tests.
- B. Factory Testing: The Supplier shall inspect control panels and equipment for required construction, electrical connection, and intended function.
- C. Functional Testing: Each pump shall be field tested in the presence of ENGINEER demonstrating its ability to operate without vibration or overheating and deliver its rated capacity under specified conditions. Specifically, the following items shall be measured at five (5) points over the entire operating range:
 - 1. Discharge head
 - 2. Suction head
 - 3. Capacity
 - 4. Pump speed
 - 5. Amperage draw
- D. Defects: Correct all defects or replace defective equipment, revealed and noted during tests. Make necessary adjustments at the time of the tests at the expense of CONTRACTOR. Repeat tests if necessary to obtain results acceptable to the ENGINEER.
- E. Performance Testing
 - 1. Performance testing of the full-scale equipment, unless otherwise stated in this Section, shall be required in accordance with Section 01650 Facility Startup.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION", are part of this Specification.
 - 1. Double Disc Pump Data Sheet

END OF SECTION

**PUMP DATA SHEET
DOUBLE DISC PUMPS
PUMPS NO. PC2-PMP1, PC2-PMP2**

Project:	Treatment and Wet Weather Upgrade Project	Manufacturers	
Owner:	Sausalito Marin-City Sanitation District	A.	Penn Valley Pump Company
Service:	Primary Sludge/Scum		No Equal (Match existing)
Pump Name:	Primary Sludge/Scum Pumps		
Eqpt. Tag Nos.	PC2-PMP1, PC2-PMP2		
Quantity:	Two (2)		

Operating Conditions		Service Conditions	
Liquid Temperature °F	Normal: 65 Max: 80 Min: 32	Ambient Temperature (°F)	Normal: 67° Max: 100° Min: 30°
Specific Gravity:	1.0 at 65 °F	Altitude (ft):	Sea Level
Vapor Pressure(psia):		Environment:	Outdoor
Viscosity at 25 °C:		Relative Humidity:	40%-100%
pH:		Duty:	Intermittent

Performance Requirements			
	Design Point 1	Design Point 2	Design Point 3
Design Flow Capacity (gpm), Normal	100		
Design Pump Head, TDH (ft)	20		
Minimum Efficiency (%)			
Minimum NPSH Available (ft)	19		
Maximum Pump Speed (rpm)	200		

Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	4	100	Horizontal
Discharge	4	100	Horizontal
Seal Type	Flexible Trunnions		

Motor Data			
Motor Horsepower:	5	Voltage:	460
Speed (rpm):	1160	Phase:	3
Enclosure Type:	TEFC	Service Factor @ rated maximum ambient temperature:	1.15
Mounting Type	See Contract Documents		
Drive Type	Constant Speed		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
No			

SECTION 11148 – SUBMERSIBLE NON-CLOG PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide submersible non-clog pumps and motors with associated piping, controls, wiring, and appurtenances, including guide bars, lifting cables, connection brackets, nameplates and access covers, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 11100 – Pumps, General, apply to this Section.
- C. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump which will satisfy the indicated requirements.
- D. All submersible non-clog pumping equipment shall be provided by the same pump and motor manufacturers.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A53 Grade B	Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.
ANSI/AWWA C200	Standards for Steel Water Pipe 6 in. and Larger
ANSI/AWWA C208	Standards for Dimension for Fabricating Steel Water Pipe Fittings
ANSI/API 610	Centrifugal Pumps for General Refinery Service
NFPA 820	Fire Protection in Wastewater Treatment and Collection Facilities

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: The CONTRACTOR shall provide submittals according to the requirements of Section 11100 Pumps General.

- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded, for each pump system installed.
 - 1. 1 person-days for installation assistance and inspection,
 - 2. 1 person-days for functional and performance testing
 - 3. 0.5 person-days for pre-startup training of OWNER'S personnel.
- B. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in two separate trips for each pump Section.

PART 2 PRODUCTS

2.1 GENERAL

- A. All submersible non-clog pumps, motors and drives shall be designed for wastewater pumping applications.

- B. Each pump shall be capable of continuous operation at full load, without cavitation or overheating of the motor, with a minimum operating water level as designated on the contract drawings or as outlined in the control strategies for each pump system.
- C. Each pump, with its motor, cable and appurtenances, shall be able to withstand continuous submergence to a minimum depth of 65 feet, when running or off, without leakage.
- D. Cooling System: Pumps with motors up to 10-hp: Motors are sufficiently convection-cooled by the surrounding environment or pumped media. A water jacket is not required.

2.2 PERFORMANCE REQUIREMENTS

- A. Each pump shall be able to operate for short periods at zero static suction head without causing any damage to any part of the unit.
- B. Refer to the Supplemental Pump Data Sheets, attached to this Specification, for specific pump requirements.

2.3 PUMP

- A. Impeller: The Impeller(s) shall be of gray cast iron, Class 35B, dynamically balanced, multiple vaned, double shrouded non-clogging design having long throughlets with acute turns. The Impeller(s) shall be capable of handling solids, fibrous materials and other matter found in wastewater.
- B. Pump and Motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T. The use of stainless steel sleeves will not be considered equal to stainless steel shafts as shaft sleeves only protect the shaft around the lower mechanical seal.
- C. Bearings: Permanently lubricated, heavy-duty axial and radial ball or roller bearings, top and bottom, double shielded with a minimum L-10 life of 100,000 hours, at continuous, maximum load and speed, supported by detailed calculations, to be submitted with the shop drawings.
- D. Seals: Independent double mechanical shaft seals, easily replaceable, oil lubricated, with moisture detector probes, alarm, and test circuits. The seals shall not require any maintenance or adjustment, nor any differential pressure to affect sealing. Material shall be corrosion resistant double tungsten-carbide with stainless steel springs.
- E. Pump, volute, oil casing, sliding: Material shall be cast iron, ASTM A-48 bracket, motor frame.
- F. Exposed bolts, nuts, washers: Material shall be Type 316 stainless steel.
- G. Wear rings

1. Volute wear ring: A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a Nitrile rubber coated steel or brass ring insert.

2. Impeller wear ring: The pump shall have a stainless steel impeller wear ring.

H. Oil Chamber: Each pump shall be fitted with an oil chamber that acts as a barrier between the pumped fluid and motor. The oil chamber shall have accessibility from the exterior of the pump and shall be filled with environmentally safe Glycol based oil. A moisture sensor probe must be installed in the oil chamber to detect moisture. A corresponding relay, located in the pump control panel, shall be used in conjunction with the seal probe to detect moisture.

I. Suction can(s) shall be provided by the pump manufacturer at no additional costs to the District or CONTRACTOR.

2.4 CONTROLS

1. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.

2.5 MOTOR

A. Motors shall meet the requirements of Section 16222 – Motors.

B. Motor: The pump motor shall be a completely sealed, electric submersible, squirrel-cage induction, shell type design, housed in an air filled watertight chamber, NEMA B type. The motor shall have a 1.15 service factor and be rated for 480 volts, 3 phase, 60 Hz. The motor shall be designed for continuous duty, capable of sustaining a minimum of 10 starts per hour. The temperature rise of the motor shall not be in excess of that specified in NEMA Standard MG1 for Class B insulating materials when operating continuously under load. The stator should be heat shrink fitted into the stator housing in order to transport heat losses most effective. The use of bolts, set screws, pins, or other fastening devices requiring penetration of the stator housing shall be rejected.

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.
2. The motor horsepower shall not be less than the maximum pump horsepower specified for each pump and the actual horsepower shall be adequate throughout the entire range of the published curve without overloading.
3. The motors shall be designed, manufactured, and tested in accordance with the requirements and recommendations for NEMA MG 1. The motors shall comply

with the latest ANSI, NEMA, and IEEE standards, and the National Electrical Code. All electrical characteristics shall be rated at 40 degrees C.

4. Motors shall be properly sized and completely compatible with the drive system supplied.
5. The motor shall include the following design and construction features to assure AFD compatibility:
 - a. Avoid loose windings-use slot fillers as required.
 - b. Insulate between phases-both end turns and in slots.
 - c. Secure end turns-tie or band both winding ends.
 - d. Avoid loose windings, use slot fillers as required.
 - e. Insulate between phases, both end turns and in slots.
 - f. Secure end turns, tie or band both winding ends.
 - g. Provide VPI treatment.
6. Be especially careful to avoid damaging winding magnet wire. Provide a larger frame size motor for the specified horsepower if necessary to provide the aforementioned features.
7. Motors shall be adjustable speed where noted in the pump schedule (suitable to be controlled by an adjustable speed drive, as described in NEMA MG 1, 1.32, and Part 30).

C. Power Cable:

1. Each pump shall be furnished with the necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog pumps. All cables shall be connected to the pumps and tested at the factory.
2. Separate power and control cables shall be adequately shielded to prevent any interference if cables are installed as shown on the contract drawings.
3. The power and control cable shall be in accordance with all applicable electrical specifications in the contract documents.
4. Power cable shall be sized according to NEC standards and shall be supplied in lengths as required for proper installation. The motor and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet.
5. Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible non-clog pumps, and of sufficient length for direct connection to field panel. Wicking fillers will not be accepted. Power cables shall keep separate from cable or cables for thermal protection and moisture detection or shall be adequately shielded to prevent interference.

6. If the cable entry is not leakproof when cable is cut below water level, the junction chamber containing the terminal board shall be hermetically sealed from the motor by elastometer compression seal (O-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

D. PUMP/MOTOR PROTECTION

1. Pump/Motor protection for the pumps in this section shall be provided at no additional costs.
2. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125 degree C (260 degree F), stop the motor and activate an alarm.
3. A leakage sensor shall be available as an option to detect water in the stator chamber.
4. The dry contacts shall change status upon occurrence of an over temperature of leakage condition so as to indicate that condition to other control components in the pump control panel.
5. In the case of an over temperature, the over temperature dry contacts shall be used to trip the pump offline.

Nameplates: Provide a nameplate for each motor. As a minimum, the motor nameplate shall meet the requirements of NEMA MG1, Part 20.

2.6 GUIDE BARS, BRACKETS AND FITTINGS

- A. Support bracket and discharge elbow: Cast duckfoot bend or discharge elbow with machined face, anchored to sump floor.
 1. Pumps shall be provided with discharge elbows for permanent installation in the wet well. The pump shall be designed with a centerline discharge. Where required, adapters shall be provided to match the pump to the discharge elbow. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the tank/wet well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a watertight contact. No portion of the pump shall bear directly on the floor of the sump. Guide bars, which shall steer the pump into proper contact with the discharge elbow, shall be non-adjustable and shall not bear the weight of the pump.

2. Connections: Machined metal-to-metal quick disconnect type, for withdrawal of unit from above, without disconnecting pipe. When lowered into place, the pump shall automatically connect and lock into the discharge pipe without touching the floor.

B. Guide bars:

1. Two guide bars shall be provided by the Pump Manufacturer with each pump for raising and lowering the pumping units. The guide bars or cables shall not support any portion of the weight of the pump. All components of the guide system including actual guide bars or cables shall be provided under this specification. The lower guide holders shall be integral with the discharge elbow. The upper guide bracket shall be furnished to support and align the bars/cables at the top of the wet well. Connection to the top slab/ access cover shall be coordinated by the CONTRACTOR.
2. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.
3. Guide bars shall be of the diameter and length recommended by the pump manufacturer for proper installation. Guide Bars shall be suitable for guiding new pumps.
4. Guide Bars, Upper guide brackets and safety hooks shall be fabricated from Type 316 stainless steel.

- C. Lifting chain and fittings: Each pump shall be fitted with up to 50 feet of Type 316 stainless steel lifting chain capable of lifting the pump and motor. The necessary fittings and the lifting cable holder shall be Type 316 stainless steel. Lifting cable holder shall be attached to the top slab, accessible from the hatch opening. Connection to the top slab/ access cover shall be coordinated by the CONTRACTOR.

2.7 PUMP ACCESS COVERS

A. General:

1. The Filter Influent Pumps have associated access hatches.
2. Frame shall include upper attachment for guide bars and attachments for lifting chain and power cable. Access frames and covers shall be sized as indicated on the drawings.
3. Each hatch shall be designed to combine covering of the opening, fall through protection and controlled confine space entry.
4. Design must assure that the fall through protection is in place before the doors can be closed, thereby protecting the next operator.
5. Frame shall drain all water that enters frame to wet well or tank below.

6. Frame hold-open mechanism shall be supplied with frame so that frame is able to hold open by itself.

B. Materials of construction

1. Plate, bars, angles, extrusions shall be aluminum. Deflection shall not exceed 1/150th of the span. Each door shall be equipped with a stainless steel hold open arm. Door shall lock open in the 90-degree position. All hardware shall be stainless steel. Angle frame shall be aluminum, with a continuous anchor flange. Hinges shall be heavy-duty design and stainless steel with a stainless steel pin. Hinges shall be bolted to the channel frame and diamond plate.
2. Each hatch shall be supplied with a stainless steel slam lock, with keyway protected by a threaded aluminum plug that is flush with the top of diamond plate.
3. Each hatch shall be supplied with a Recessed Padlock Clip for OWNER'S padlock. Padlock Clip shall be covered with a separate hinged aluminum cover.
4. Each cover shall be equipped with a stainless steel lift handle. The lift handle shall be flush with the top of diamond plate.
5. The safety grate shall be aluminum and designed to withstand an H-20 wheel load.
6. Grate openings shall allow for visual inspection, limited maintenance and float adjustments while the safety grate fall through protection is left in place.
7. Each grate shall be provided with a permanent hinging system, which will lock the grate in the 90-degree position once opened.
8. Each grate supplied with a locking device (for OWNER'S padlock) that will prevent unauthorized entry to the confined space.

C. Protective Coating

1. Grate shall be coated with an OSHA type safety orange color. The aluminum safety grates shall receive a two-coat powder coat system, applied by the electrostatic spray process. The base coat is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils. The top coat is a mar-resistant, TGIC polyester powder coating with a minimum thickness of 2-4 mils. Each coat shall be baked at 350-375 degrees F until cured.

2.8 SPARE PARTS

- A. The requirements of Section 11100 – Pumps, General, apply to this section.
- B. The following spare parts shall be furnished as a minimum:

Item	Quantity (per pump model)

Item	Quantity (per pump model)
Sets of wearing rings complete with fasteners.	1
Set of O-Rings	3
Lower mechanical seal set	1
Set of bearings	1
Submersible cable of required length with termination kit	1 (for each size pump)
Impeller (trimmed; balanced, statically, dynamically)	1
Set of special tools (as required for pumping unit disassembly)	1 (for all pumps)

- C. No additional compensation shall be provided for provision of the items cited above.

2.9 PROTECTIVE COATING

- A. Manufacturer to provide prime coat of Standard Heavy Duty Paint System suitable for the working environment of the pump.
- B. All ferrous surfaces and passages of pumps, motors, and supports, in contact with the process fluid, shall be epoxy-coated in accordance with Section 09960 – Protective Coatings, or with the pump manufacturer's equivalent coating.

2.10 MANUFACTURERS

- A. Manufacturer's Experience:
1. The pump manufacturer shall have a minimum of 1,000 heavy-duty submersible non-clog wastewater pumps installed and operating for no less than 5 years in the United States.
 2. Manufacturer Experience shall be in accordance with Section 11100 – Pumps, General.
- B. Manufacturers:
1. Flygt to match existing equipment
 2. No other pump manufacturers shall be acceptable.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

The requirements of Section 11100 – Pumps, General apply to this section.

3.2 INSTALLATION

The requirements of Section 11100 – Pumps, General apply to this section.

3.3 TESTING

- A. General: In addition to the requirements listed in Section 11100 – Pumps, General, all submersible non-clog pumps shall be factory, functional and performance tested as listed below.
- B. Factory Testing
 - 1. Testing should be to Hydraulic Institute Level A Standards.
 - 2. In addition to the requirements in Section 11100 – Pumps, General, each pump shall be tested for performance at the factory to determine head versus capacity, efficiencies, and kilowatt draw required for the operational points indicated in the data sheets. All tests shall be run in accordance with the American Hydraulic Institute Standards. Testing shall also include the following:
 - a. Impeller, motor rating, and electrical connections shall first be checked for compliance with the Contract Documents.
 - b. A motor and cable insulation test for moisture content or insulation defects shall be made.
 - c. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
 - d. The pump shall be run for 30 minutes submerged, a minimum of 6 feet under water, at 1/4, 1/2, 3/4, and full flow, without cavitation or overheating.
 - e. After operational test described below, the insulation test described above shall be performed again.
 - f. A written report stating the tests have successfully been completed and providing the results of the test shall be furnished for each pump.
 - g. Verification of cavitation-free service and absence of motor overheating during conditions simulating the actual operating conditions after installation at a water level equivalent to the invert of the influent sewer of the pump station.
 - h. Pump seals shall be designed for complete water tightness at 65 feet submergence for 30 minutes and data on factory testing and quality control shall be submitted with the shop drawings.
- C. Functional Testing
 - 1. The requirements of Section 11100 – Pumps, General, apply to this section.

D. Performance Testing

1. The requirements of Section 11100 – Pumps, General, apply to this section.

E. Operational Testing

1. The requirements of Section 11100 – Pumps, General, apply to this section.

3.4 SUPPLEMENTS

A. The supplements listed below, following “END OF SECTION”, are part of this Specification.

1. Filter Feed Pump Data Sheet
2. Return Pump Data Sheet

END OF SECTION

PUMP DATA SHEET
SUBMERSIBLE NON-CLOG PUMPS
PUMPS NO. FIL-PMP1, FIL-PMP2, FIL-PMP3

Project:	Treatment and Wet Weather Upgrade Project	Manufacturers	
Owner:	Sausalito Marin-City Sanitation District	A.	Flygt
Service:	Secondary Effluent		No equal
Pump Name:	Disk Filter Feed Pumps		
Eqpt. Tag Nos.	FIL-PMP1, FIL-PMP2, FIL-PMP3		
Quantity:	Three (3)		

Operating Conditions		Service Conditions	
Liquid Temperature °F	Normal: Max: Min:	Ambient Temperature (°F)	Normal: 67° Max: 100° Min: 30°
Specific Gravity	1.0 at 65 °F	Altitude (ft)	Sea Level
Vapor Pressure(psia)		Environment	Outdoors
Viscosity at 25 °C		Relative Humidity	100%
pH		Duty	Continuous

Performance Requirements			
	Design Point 1 – Design point (3 pumps)	Design Point 2 – Shutoff Head	Design Point 3 (2 pumps)
Design Flow Capacity (gpm), Normal	6246	0	2083
Design Pump Head, TDH (ft)	27	42	20.4
Minimum Efficiency (%)	62	-	62
Minimum NPSH Available (ft)	30	30	30
Maximum Pump Speed (rpm)	1160	1160	1044

Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	10	150	
Discharge	10	150	Horizontal
Seal Type	Double independent mechanical		

Motor Data			
Motor Horsepower:	25	Voltage:	460
Speed (rpm):	1800	Phase:	3
Enclosure Type:	Submersible, EP	Service Factor at rated max. ambient temperature:	1.15
Mounting Type	See Contract Documents		
Drive Type	VFD. Operating Speed Range: 100% to 50% of Rated Speed		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
No	Hazardous Location: Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

**PUMP DATA SHEET
SUBMERSIBLE NON-CLOG PUMPS
PUMPS NO. R-PMP1, R-PMP2**

Project:	Treatment and Wet Weather Upgrade Project		Manufacturers	
Owner:	Sausalito Marin-City Sanitation District		A.	Flygt
Service:	Plant drainage flows			No equal
Pump Name:	Recycle Pumps			
Eqpt. Tag Nos.	R-PMP1, R-PMP2			
Quantity:	Two (2)			
Operating Conditions			Service Conditions	
Liquid Temperature °F	Normal:	Ambient	Normal: 67°	
	Max:	Temperature (°F)	Max: 100°	
	Min:		Min: 30°	
Specific Gravity	1.0 at 65 °F		Altitude (ft)	Sea Level
Vapor Pressure(psia)			Environment	Plant drainage wet well
Viscosity at 25 °C			Relative Humidity	100%
pH			Duty	Continuous
Performance Requirements				
	Design Point 1		Design Point 2	
Design Flow Capacity (gpm), Normal	467		0	
Design Pump Head, TDH (ft)	52		83	
Minimum Efficiency (%)	75		-	
Minimum NPSH Available (ft)	30		30	
Maximum Pump Speed (rpm)	1720		1720	

Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	4	150	
Discharge	4	150	Horizontal
Seal Type	Double independent mechanical		

Motor Data			
Motor Horsepower:	10	Voltage:	460
Speed (rpm):	1720	Phase:	3
Enclosure Type:	Submersible, EP	Service Factor at rated max. ambient temperature:	1.15
Mounting Type	See Contract Documents		
Drive Type	VFD. Operating Speed Range: 100% to 50% of Rated Speed		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
No	Hazardous Location: NFPA 820 Class 1 Division 1 Location. Furnish motors for hazardous (classified) locations that conform to UL 674 or have an applied UL listing mark		

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SECTION 11231 – CIRCULAR CENTER-FEED CLARIFIER

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one (1) primary circular center-feed clarifier consisting of sludge collector and skimming equipment complete and operable, in accordance with the Contract Documents.
- B. The equipment furnished for each clarifier mechanism shall include center assembly with drive unit, drive control, remote mounted control panel, stationary influent column with upper inlet openings, flocculating feedwell, center cage, sludge removal arms, scum skimmer, scum box, weirs, baffles, and anchor bolts, and all other appurtenances required or indicated.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. American Society of Testing Materials (ASTM):
- B. American Iron and Steel Institute (AISI), Heat Treated Steel Specifications
- C. American Gear Manufacturers' Association (AGMA), Gear Ratings
- D. American Welding Society (AWS), Current Standards
- E. Anti-friction Bearing Manufacturers' Association (AFBMA), Bearing Life Specifications
- F. National Electrical Manufacturer's Association (NEMA), Motor Design Standards and Standards for Control Enclosures
- G. National Fire Protection Association (NFPA)

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 - Submittals, CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's calculations substantiating the output torque rating of the complete drive mechanism, including gears and pinions. The calculations shall clearly specify the values used for the following design parameters for surface durability and strength ratings. Calculations shall be certified by a Professional Engineer.
 - a. Number of Pinions
 - b. Actual Face Width
 - c. Tooth Geometry Factor (I & J Factors)
 - d. Load Distribution Factor

- e. Allowable Contact Stress
 - f. Allowable Bending Stress
 - g. Pinion Pitch Diameter
 - h. Tooth Diametric Pitch
 - i. Hardness Ratio Factor
 - j. Elastic Coefficient
 - k. Life Factor
 - l. Worm and Worm Gear Pitch Diameter
2. The load distribution factor shall be determined as described in the referenced AGMA standard above. The net face width for surface durability calculations shall not exceed 90 percent of the actual face width of the narrower of the two mating gears. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatments used.
 3. MANUFACTURER's product data including catalogue cuts.
 4. Complete certified equipment drawings, showing all dimensions, weights, materials of construction, structural members, sludge collection members, welds, torque ratings, and gears.
 5. Foundation, installation, and grouting plans.
 6. Anchor bolt placement measured from construction joints in the concrete structure. Anchor bolt details shall include projections from concrete.
 7. Type and size of structural details for sludge draw off pipes, where appropriate, including method of return sludge flow control, and all pipe connection details.
 8. Skimming device details.
 9. Equipment drive and drive guard details.
 10. Size, make, and type designation of electric motor, including mounting details.
 11. Type, specifications, detail drawings and information on type, input and output speeds, exact gear ratios, service factor (24-hour continuous service), capacity, and efficiency of gear reducer units and drive assembly and diameter of ball race.
 12. Details and description of the overload protection assembly. Details submitted shall clearly demonstrate the adequacy of the overload protection provided by the assembly proposed. Overload alarm contact shall be provided as shown on the control diagram.
 13. Seismic calculations in accordance with to requirement of Drawing S-1. The calculations shall clearly specify the values used. Calculations shall be certified by a Professional Engineer registered in California.
 14. A list of the three most recent installations, where similar equipment by the MANUFACTURER is currently in service, including contact name, telephone number, and address.

- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
- B. Warranty
 - 1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranties and Bonds.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 - 1. 1 person-days for installation assistance and inspection,
 - 2. 1 person-days for functional and performance testing
 - 3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – PC2 (PRIMARY CLARIFIER NO. 2)

- A. The clarifier mechanism shall be of the center-drive type, supported on a stationary influent column, with the flow entering at the bottom of the influent column and flowing

upward to the inlet openings near the water level. The clarifier mechanism shall be furnished and installed complete with all supports, electric driveheads, sludge collector, mechanical equipment, electrical work and appurtenances ready for operation. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Guards shall be furnished for all exposed moving shafts, drives, or parts as required by the applicable safety codes. All main drive assemblies shall be provided by the equipment MANUFACTURER.

- B. The drivehead torque shall be defined in Section 2.2. The gear teeth shall not be stressed to more than allowed, according to the referenced AGMA Standard, at a load equivalent to a value of the momentary peak (stalled) torque. The entire mechanism shall be capable of withstanding an impact load of the momentary peak (stalled) torque, without sustaining damage or permanent deformation. The 20-year maximum continuous running torque shall be a computed value according to the referenced AGMA standard below.
- C. Workmanship and Design: All parts of the equipment shall be amply proportioned for long, continuous, uninterrupted service. Provision shall be made for easy access for service or replacement of parts. Corresponding parts of multiple units shall be interchangeable. Workmanship shall be first class, with all welding in accordance with the latest applicable code of the American Welding Society. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence. Welds on submerged surfaces and edges shall be of the continuous type. The complete drive mechanism shall be designed for the maximum continuous running torque per AGMA 908-B and 2001-B for a minimum life of 20 years or 175,000 hours, unless otherwise specified, and a momentary peak (stalled) torque of twice the maximum continuous running torque. The maximum allowable stresses on structural steel members shall not exceed those permitted by the latest AISC specifications for applicable design, at twice the maximum continuous running torque.
- D. The equipment components shall be designed to minimize field erection requirements. No field welding will be accepted except at the access walkway bridge splice. All major equipment sections shall be factory assembled requiring only field bolting of major equipment sections to each other to form the assembled equipment.

2.2 PERFORMANCE REQUIREMENTS

Influent Flow , Total: (mgd)

Minimum	0.5
Average Dry Weather	1.3
Peak Day Wet Weather	6
Peak Instantaneous Wet Weather	13

Overflow: (gpd/sf)

Minimum	210
Average Dry Weather	631
Peak Day Wet Weather (1 Unit in Service)	2,525
Peak Instantaneous Wet Weather (2 Units in Service)	2,736
Tank Diameter (ft)	55
Side Water Depth (ft)	9.5
Freeboard (in)	33
Bottom Slope (in/lf)	1
Walkway, width (ft)	N/A
Influent Column, minimum dia (in)	20
Flocculating Feed Well Dia. (ft)	14
Flocculating Feed Well Depth (ft)	5
Weir V-notch depth (in)	3
Weir V-notch spacing (in on center)	8
Scum Baffle Depth (in)	18
Scum Drain, dia (in)	6
Motor, minimum (hp)	0.5
Motor, maximum (rpm)	1,800
Sludge Arm Tip Speed, min (fpm)	8

Sludge Arm Tip speed, max (fpm)	10
Continuous running torque (ft-lbs)	16,500
Momentary peak (stalled) torque (ft-lbs)	50,000
Drive Rotation	Clockwise

2.3 CENTER DRIVEHEAD

- A. The center drivehead for the Primary Clarifier shall be designed for the torque values listed in the Performance Requirements. It shall turn the mechanism at the design collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L 10 life of 20 years or 175,000 hours. The drivehead shall be able to produce and withstand the momentary peak (stalled) torque listed in the supplemental data sheets, while starting. The continuous torque shall be defined as the minimum torque at which the drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified sludge collector arm speed. The center drivehead gear shall be designed to a minimum AGMA 6 rating when rated in accordance with the latest AGMA standards. The maximum continuous running torque rating of the complete drive shall be based on the smaller of the two values determined from the above AGMA standard.
- B. Physical Characteristics: The drivehead shall consist of a removable internal main gear, pinion, secondary worm gear set, support base, and drivehead bearing. The drivehead shall be mounted on the center column and support the entire rotating weight of the mechanism. The main internal gear shall be fabricated of alloy hardened steel or nodular iron. The main gear shall have a face depth to diameter ratio of 0.15 or greater for nodular iron and 0.07 or greater for alloy hardened steel. The pinion shall be heat treated alloy steel and forged integral with the shaft, or shall be alloyed nodular iron. The worm gear shall be of hardened alloy steel, meehanite, or centrifugally cast bronze. All gears shall be fully enclosed and running in oil. Support base for the drive shall be of cast iron, meehanite, or welded steel, to assure rigidity. Oil and dust shields shall be provided. Seals shall contact a machined surface. The drive bearing shall include a hardened replaceable raceway, or it shall be a forged steel precision gear/bearing set, with fully contoured raceways. Raceway liners, if used, shall be either temperature drawn or bearing quality steel, heat-treated to minimum 40 Rc. An oil sight glass shall be provided for the upper and lower oil reservoirs. Balls shall be grade 500 and heat treated to 60 Rc. Readily accessible lubricant fill and drain pipes with necessary fittings shall be provided.
- C. Turntable: The turntable base shall have an annular raceway for a ball race upon which the rotating assembly rests. It shall have a maximum allowable deflection of 0.024 inches with an allowable modulus of elasticity of 25×10^6 psi when fabricated from steel and 17×10^6 psi when cast iron. The center cage and sludge collection arms shall be fastened to and hung from the gear casing. Ball bearings shall be of the finest quality high carbon, chrome alloy steel balls running in renewable heat-treated alloy steel races mounted in the turntable base and in the gear casting, or in fully contoured races, as part of a precision gear bearing set. The balls shall run in an oil bath which shall be protected by a felt seal and steel dust shield. The oil baths shall be provided with a fill pipe, plug, sight gage indicator, and drain plug.

- D. Speed Reducing Unit: The worm gear shall in turn be driven by a vertical chain drive or direct connection from a gear motor or worm or helical gear speed reducing unit made to AGMA standards and bearing the AGMA nameplate. The speed reducing unit shall have a service factor of 1.25. Speed reducer helical or planetary gearing shall provide at least 95% power transmission efficiency per stage. There shall be no overhung pinions without lower bearings. The lower pinion bearing shall not be located at an elevation below the turntable base. The pinion shall be one piece extending through the upper and lower bearings of the two housings (worm gear and main gear) or keyed to the pinion shaft. As a safety feature, the speed reducer shall be back driveable to release any stored energy as the result of an over torque condition.
- E. Motor: Power supply to the equipment shall be 480 volt, 60Hz, 3-phase, unless otherwise indicated. The motor shall be a 1800 rpm synchronous speed, squirrel cage, induction type, totally enclosed, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a service factor of 1.15, all in accordance with Section 16222. The motor shall be not less than 0.5 HP and the connected load shall not exceed 85 percent of the motor nameplate horsepower rating under any anticipated operating condition. Motor shall be suitable for explosion proof class 1 div 1 per NEC.
- F. Center Drive Platform:
 - 1. General: A center drive platform shall provide access to the center assembly and drive control. It shall rest on the center assembly and be provided with connections to the cover structure, where applicable. To meet the electrical code, the center platform shall provide not less than 2.5 feet of working clearance around the drive unit and all auxiliary equipment shown on Contract Documents, including hose bib and rack.
 - 2. Center drive platform shall consist of aluminum plank grating with necessary supports per Section 05500 Miscellaneous Metals.

2.4 INFLUENT COLUMN, CENTER CAGE, AND FLOCULATING FEEDWELL

- A. Stationary Influent Column: A steel center column shall be provided to support the drive, collector mechanism, and center drive platform. The top of the column shall have a drive mechanism mounting plate which shall be set plumb with the centerline. The drive unit shall be positioned and leveled prior to the center column being grouted in place. The column shall be fabricated of minimum 3/8-inch thick 316 steel plate with supporting flange, anchored to the concrete base with a minimum of eight 1-1/8-inch diameter 316 stainless steel anchor bolts. The CONTRACTOR shall obtain information from the equipment MANUFACTURER to accurately locate these anchor bolts. The structure shall provide adequate support for the entire mechanism plus live load torque, with an adequate factor of safety to eliminate excess deflection or vibration. There shall be a minimum of four (4) large inlet ports as shown on the Contract Drawings to diffuse flow into the influent dispersion well. Influent discharge ports shall be included at the upper end of the influent column. These ports shall diffuse the flow entering the tank and insure low velocity into the Flocculating Feedwell. Influent velocity shall not exceed 1.0 fps at the average day flow rate specified.

B. Center Cage:

1. The center cage shall be of steel box truss construction, a minimum of 2'-10" square. The center cage shall be of an all-welded construction made up of structural 316L steel members having a minimum thickness of 1/4".
2. The center cage shall be provided with connections for the 2 sludge removal arms, and flocculation well supports. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The cage and arms shall be designed to withstand twice the 100% running torque rating of the drive without overstressing the members.

- C. Flocculating Feedwell: Provide a flocculating feedwell on each primary clarifier as shown on the Contract Drawings. The feedwell shall be supported by structural members attached to the center rotating cage. The feedwell shall be fabricated from minimum 3/16 inch 316 stainless steel plate with upper and lower reinforcing rim angles as required and stiffeners as required. A minimum of eight (8) scum ports, 6 inches high x 16 inches long, shall be provided equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level. Scum ports shall be free to allow scum to escape; as an alternate to scum ports, the feedwell rim may be submerged slightly below average liquid level to allow floating material to exit the feedwell area. Elevations of these openings shall be coordinated with weir elevations to allow scum to exit feedwell at all flow rates.

2.5 SLUDGE COLLECTION ARMS

A. Sludge Collection Arm

1. The primary clarifier mechanism shall include two (2) full radius sludge rake arms of steel truss construction with spiral-shaped steel scraper blades and adjustable 20 gauge 316 stainless steel squeegees, secured to the blades by Type 316 stainless steel bolts and nuts. The squeegees shall project 1-1/2 inches below the bottom of the rake blades. The blades shall rake the heavy sludge to the center sludge hopper.
2. The truss members and rake blades shall be of adequate size to withstand twice the continuous running torque and be capable of raking any normal sludge deposit encountered without distorting the truss arms or the center cage. If rectangular box construction is used, bracing shall be provided in each and every bay where the truss members meet. If members are placed back to back, there shall be a space between them of at least 1/2-inch.
3. The rake blades shall consist of a minimum 3/16" thick 316 stainless steel plate blade. The blades shall be constructed to a logarithmic spiral curve with a constant 30-degree angle of attack. Blade depth shall vary from 9 inches deep at the outer portion of the rake arm, to 27 inches near the tank center. Each rake truss support arm shall be provided with the necessary outrigger bracing and other blade support structures to ensure that the complete blade can be properly located and adjusted in the field. The structural calculations for the rake arm shall include an analysis of the torsional loads from the spiral curve blade. The cage and rake arms shall be designed such that calculated stresses do not exceed the AISC allowable at twice the drive 100% rating.

2.6 SCUM SKIMMER, SCRAPER, AND SCUM BOX

A. Scum Skimmer

1. Provide skimming devices as part of the each clarifier mechanism. Each mechanism shall be furnished with two (2) skimming arms which shall be arranged to sweep the surface of the clarifier, automatically removing scum and floating material into a scum box at the periphery of the tank.
2. The skimming system shall be designed, constructed, and installed to effectively capture and remove scum. Once installed, the system shall be tested and adjusted to provide proper operation. The system shall operate without jerking or losing the accumulated scum. Any modifications to the skimmer, scum box, scum scraper or anti-rotational baffle required to obtain proper operation shall be performed by the CONTRACTOR at no additional cost to the OWNER.
3. The rotating skimmers shall consist of a continuous skimming blade extending from the center flocculation well towards the tank periphery. At the end of each skimmer blade, a hinged scum scraper with neoprene wipers shall be provided to remove scum and deposit in the scum box. The skimmers shall be supported and driven from the full diameter rake arms by A-frame or other rigid supports.
4. The skimmer blades shall be constructed using a vertical steel plate, reinforced as necessary to ensure adequate stiffness to maintain contact with the stationary anti-rotational baffle. The skimmer blades shall be attached to the rake arms and shall be oriented so that the interior end is essentially tangent to the flocculation well. An anti-rotation scum baffle shall be provided to improve the collection of surface scum. The skimmer blades shall angle back from the outside of the flocculation well to the center of the rake arm to provide a scissoring action between the skimmer blade and the anti-rotational baffle to force the scum to the tank periphery.

B. Scum Scraper:

1. The scum scraper shall consist of a hinged scraper assembly mounted on the outer end of the skimmer. The scum scraper shall maintain contact with the scum baffle as it travels around the tank periphery. The hinged scraper assembly shall be designed to form a pocket at least 8" deep by 6'-0" wide for trapping the scum. The hinged scraper shall be designed, constructed, and installed to ensure continual contact and proper alignment between the wiper blade, scum baffle and scum box so that the scum is effectively collected and conveyed up the beach to the scum trough without jerking or losing the accumulated scum.
2. The hinged scraper shall be counter weighted to provide adjustment. Spring-operated mechanisms are not acceptable. The scraper shall be equipped with adjustable neoprene wiper blades on the bottom and ends of the scraper blade. The neoprene wipers shall be continuous and shall be of sufficient stiffness to maintain contact with the scum box and scum baffle and prevent loss of scum. The neoprene shall be at least 3/8-inch thick and shall be installed with minimum projection from the steel scraper blade.

C. Scum Box:

1. The scum box shall be supported from the tank wall and shall be connected to the scum sump by a 6-inch diameter scum pipe. The scum box shall be made of 316 stainless steel plate and shall serve as an integral section of the tank's scum baffle. The scum box shall be 6'-0" wide.
2. The scum box assembly shall have vertical steel sides, an approach ramp, flat scum accumulation area at least 2'-6" long, sloping beach, scum trough and exit ramp. The scum box design and location shall ensure that the scum on the surface of the tank is captured by the skimmer blade and conveyed by the scissoring action of the anti-rotational baffle to the scum box without losing the accumulated scum. The scum box shall be designed so that the skimmer smoothly enters the scum box, traps the scum in the accumulation area, and lifts the scum up the beach and into the scum trough without jerking or losing the accumulated scum. The exit ramp shall provide a smooth return of the skimmer to its normal operational position.
3. A 6-inch outlet shall be provided on the scum box for the scum discharge pipe. A 6-inch diameter pipe and flexible connector shall be provided to connect the scum box to the scum outlet pipe in the tank wall.

2.7 CLARIFIER ACCESSORIES

- A. General: MANUFACTURER shall coordinate the Effluent Weir, Scum Baffle, and Density Current Baffle design and installation requirements with the clarifier mechanism, scum box and launder effluent channel and clarifier cover configurations.
- B. Effluent Weirs, Scum Baffles, and Density Current Baffle
 1. General: Provide and install fiberglass weir plates, scum baffle plates, and scum baffle supports as shown on the plans. Included shall be necessary butt and splice plates at each weir and baffle plate joint to prevent short circuiting. All hardware shall be type 316 stainless steel unless otherwise specified.
 2. Materials
 - a. Resin: the resin shall be commercial-grade polyester thermosetting resin, appropriate for wastewater applications. The resin shall contain no fillers or additives except a thixotropic agent (up to 5 percent by weight) for viscosity control and pigments which are light stable, not soluble in water, and compatible with the resin.
 - b. UV Resistance: ultraviolet stabilizers are required in all laminates exposed to ultraviolet light, pigmentation or ultraviolet absorbers are acceptable.
 3. Finish and Appearance: Plates shall have uniform, smooth, resin rich surfaces and shall be free of voids and porosity, without dry spots, crazes or unreinforced areas. All plates shall have a glass content of not less than 30% by weight.
 4. Minimum Physical Properties: MANUFACTURER shall furnish certified test reports of the physical and mechanical properties of the product. Each panel shall have the following minimum physical properties.

Tensile Strength	12,000 psi per ASTM D 638

Flexural Strength	20,000 psi per ASTM D 790
Flexural Modulus	1.4 x 10 ⁶ psi per ASTM D-790
Hardness	Barcol 60 per ASTM D 2583

5. Effluent Weirs: The effluent weirs shall consist of 1/4-inch thick by 9-inch deep fiber glass plate sections with 3-inch deep 90 degree V-notches at 8-inch on center intervals. The weir sections shall be curved and fastened to the tank wall with washers, clamps, stainless steel anchor bolts and hex nuts to allow vertical adjustment. Effluent weir plates shall be of standard length not to exceed 12 feet with closure plates.
6. Scum Baffles: The scum baffles shall consist of curved sections of 1/4-inch thick by 18- inch deep fiber glass plate attached to the tank wall by fiber glass brackets, stainless steel anchor bolts and hex nuts, to enable 1-inch vertical and sufficient radial adjustment to keep baffles round and always in contact with the scum skimmer. Spacing of holes for mounting brackets shall be a maximum of 48 inches for curved walls. The scum baffle mounting brackets shall have a width of not less than 3 inches, a base length of not less than 6 inches and a depth of not less than 6 inches. Brackets shall have a nominal thickness of 1/4 inch. The baffle shall be stiffened as required, using rolled stainless steel angles, to maintain the baffle in the proper position and prevent flexing.

2.8 MATERIALS OF CONSTRUCTION

- A. General: All materials used shall be suitable for service in a moist, corrosive environment, as encountered in water and wastewater treatment plants.
- B. Plates and Structural Members: Except where otherwise specified or shown, all plates and structural members designed for submerged service shall have a minimum thickness of 1/4-inch. All steel plates and structural members shall be Type 316 stainless steel. Type 316L stainless steel shall be used for welded components.
- C. Bolts and Nuts: All bolts, nuts, anchor bolts, and washers shall be of Type 316 stainless steel, in accordance with Section 05500, Miscellaneous Metals, as specified for submerged service; they shall be of high strength and sized for the intended purpose. Stainless steel split lock washers or locknuts shall be used on all bolted connections. All bolt heads and nuts shall be hexagonal. Anchor bolts shall be cast-in-place in new concrete.

2.9 CONTROLS

- A. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.
- B. All items installed under the primary clarifier cover shall be rated for a Class I Div 1 hazardous area.
- C. Overload Protection:

1. Overload Protection: The overload device shall be provided in a local control NEMA 4X (316 SS) corrosive resistant enclosure. The device shall be actuated by thrust from the worm shaft or rotation of the secondary gear reducer, which shall operate 2 switches (the alarm switch at 85 percent of maximum continuous running torque and the motor cutout switch at 100 percent of maximum continuous running torque). These 2 switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque dial indication shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 100 percent of drive 100% rating running torque. The secondary housing may not be allowed to rotate or have exposed linkage rods or bars to activate the torque device.
2. A shear pin device, set for 140% of the AGMA rated torque, shall be furnished. The shear pin shall be selected to break when the load on the mechanism achieves 140% of the maximum continuous operating torque specified. A NEMA 4X limit switch shall be provided to activate when the shear pin breaks.
3. High Torque Alarm Light: Provide a 120 volt, weatherproof, electronic flasher or rotating amber beacon, common alarm light mounted to the clarifier control panel.
4. High Torque switch: Switches in a weatherproof enclosure shall be provided to actuate an alarm at 85 percent of maximum continuous running torque and to shut down the motor at the maximum continuous running torque. These switches shall be accurately factory calibrated and adjusted to twice the maximum continuous running torque.

D. Scum Box Spray Assembly:

1. A limit switch shall activate a solenoid valve and scum trough spray system as the skimmer arm approaches. The scum box spray assembly including the limit switch, spray nozzle, solenoid valve, etc., shall be provided by the MANUFACTURER.

E. Clarifier Local Control Panel:

1. Clarifier Local Control Panel shall be a NEMA 4X 316 stainless steel panel which shall have the following devices:
 - a. Start and Stop push buttons and a Reset push button
 - b. HOA selector switch
 - c. Green RUN pilot light
 - d. Common amber FAULT pilot light and NEMA 4X flasher
 - e. Hi torque alarm amber pilot light
 - f. Hi hi torque shut down amber pilot light
 - g. Control Power available white pilot light
 - h. Dry contact for each of the following signals:
 - 1) Run
 - 2) Torque Alarm
 - 3) Overload
 - 4) Torque shut down alarm
 - 5) In Auto mode
 - i. Run time meter (six digit)
 - j. Thermostatically controlled panel space heater

2. Clarifier Local Control panel shall be suitable for wall mounting with all required internal devices such as motor starter, control relays, fuses, transformer etc.. as a complete UL 508 approved assembly. Provide nameplate as per DIV 13. Each control device such as limit switches, torque switches etc.. when connected to the control panel shall be provided with an intrinsically safe relay located in the control panel for compliance with National Electrical Code.
3. Control Functions of the clarifier shall be as specified in DIV 13.

2.10 SPARE PARTS

- 1 set - all bearings and bearing seal rings for drivehead, except the main turntable bearing
- 1 set - all gaskets for drivehead
- 1 set - spur gear sea
- 1 set - shear pins
- 1 set - any special tools required to assemble, disassemble, or maintain the equipment
- Lubricants for one year's operation.

2.11 PROTECTIVE COATING

- A. All ferrous metals and aluminum in contact with other metal or concrete shall be painted in accordance with Section 09960, Protective Coatings.

2.12 MANUFACTURERS

A. MANUFACTURER'S Experience:

1. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized circular center feed clarifiers and appurtenances for a minimum of 10 years with at least one successful installation in the recent past and a successful record of operation in wastewater or water treatment plants. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer's recommendations and the Contract Documents.
2. Equipment of comparable size and complexity shall have the following characteristics:
 - a. List of five (5) installations of equipment in successful operation of the same design in all essential regards and of the approximate capacity as specified giving location, date of initial operation, capacities and condition of operation.
3. To show evidence of being able to provide the quality of equipment and services described in this specification, the equipment supplier shall submit their quality

system ISO 9001 certification or similar Quality Management System. The quality procedures shall provide for a means of qualifying all sub-vendors and shall specify that the fabrication facility is a critical vendor and shall require inspection. The quality system shall be audited by a third party independent inspector. Certification shall remain in effect throughout the project startup.

- B. Unit Responsibility: All equipment components of the clarifier mechanism including the center column, influent dispersion well, flocculating well, center drive cage, sludge collector arms, scum skimming system, center drive mechanism, drive motor, electrical controls, local control panel and overload devices and alarms, shall be furnished by the same MANUFACTURER. Some equipment may require modification from the MANUFACTURER's standard.
- C. Manufacturers or Equal:
 - 1. WesTech
 - 2. Ovivo
 - 3. ClearStream
 - 4. Kusters Water
 - 5. Walker Process Equipment
 - 6. Envirodyne Systems

PART 3 EXECUTION

3.1 GENERAL

- A. The equipment shall be fabricated, erected, assembled, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment MANUFACTURER as accepted by the ENGINEER. All units shall be lubricated in strict accordance with the MANUFACTURER's instructions.

3.2 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.
- B. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.
- C. All components shall be erected immediately upon receipt from the clarifier MANUFACTURER or stored in strict conformance with storage recommendations provided by the clarifier MANUFACTURER in the operations and maintenance manual.

- D. The mechanism shall be lubricated in strict accordance with the instructions of the clarifier MANUFACTURER's field service representative. The required lubricants shall be provided by the CONTRACTOR.

3.3 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.
- B. Grouting the Primary Clarifier Tank Floors : After the equipment has been erected, a 2-inch layer of grout shall be applied to the tank floor, using screeds installed on the mechanism rake/suction arms to form the finished surface. Grouting shall not be done until the mechanism has been inspected by the MANUFACTURER. To prepare the base slab, acid etch and apply epoxy bonding agent per Section 03600, Grout. Preparation of the base slab surface shall be accepted by the CONSTRUCTION MANAGER prior to grouting. Grouting procedure and the grout mix shall be as recommended by the MANUFACTURER, in accordance with Section 03360 and as accepted by the ENGINEER. The grout mix shall be sand and cement, and in no event shall the mix contain aggregate.

3.4 TESTING

- A. General: After installation of the equipment and after completion of the services of the MANUFACTURER's representative, and when plant influent is available, the CONTRACTOR shall operate each unit to demonstrate its ability to operate continuously without vibration, jamming, or overheating and to perform its specified functions satisfactorily. Any defects shall be corrected promptly, or defective equipment replaced. All final adjustments necessary to place the equipment in satisfactory working order, including leveling of the weir with reference to the liquid in the tank, shall be made at the time of the above test.
- B. Functional Testing
 - 1. Each clarifier mechanism and alarm system shall be dynamically field torque tested to 100 percent of the specified maximum continuous running torque and shall be statically field torque tested at twice the continuous running torque. Each mechanism shall be tested in the presence of the ENGINEER and MANUFACTURER by applying the load evenly to each of the two full diameter arms, before the mechanism is accepted and placed into operation.
 - 2. The dynamic test shall be performed on the clarifier mechanism to verify accurate torque indication and adequacy of the mechanism to safely withstand the specified maximum continuous running torque. The test shall accurately depict actual operation of the mechanism and shall not apply impact loading, jerky loading, or abnormal conditions which may reduce the life of the equipment.
 - 3. A torque test device shall be attached near the outer end of each rake arm. The device shall allow load to be gradually applied uniformly to each arm as the arm rotates. Readings of the load applied at the arm versus the torque indicator reading shall be taken at 100 pound increments until the specified cut out torque is achieved. This load shall be applied over not less than one half revolution of the mechanism.
 - 4. The CONTRACTOR shall perform a static torque test on each mechanism after successful completion of the dynamic torque test. The testing shall be carried out

under the supervision of the MANUFACTURER with the approval of the ENGINEER before the mechanisms are placed into operation. The purpose of the test shall be to verify the structural integrity of the mechanism.

5. The static torque test shall consist of securing the rake arms by cables to anchor bolts installed by the CONTRACTOR in the tank floor at locations recommended by the MANUFACTURER. A torque load shall be applied evenly to the two full diameter rake arms by means of a ratchet lever and hydraulic cylinder connected to the cable assembly. The magnitude of the applied torque load shall be measured by a calibrated pressure reading and the distance of the line of action of each cylinder from the centerline of the mechanism. Readings shall be taken at 100 percent, 150 percent, and 200 percent of the maximum continuous running torque specified. Loads shall not be applied by turning on the motor.
6. Actual torque versus indicated torque shall be accurately indicated within 7 percent of full scale at all torque readings.
7. There shall be no permanent deformation of any component. If deformation does occur, or correct torque is not achieved, the defective parts shall be replaced by the CONTRACTOR and then retested at no cost to the OWNER.

END OF SECTION

SECTION 11305 – HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall p with electric motors and all appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents.
- B. The Supplier shall examine the site conditions, intended application, and operation of the pump system and recommend the pump that will satisfy the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: The CONTRACTOR shall provide submittals according to the requirements of Section 11100 Pumps General.
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative.** In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 1 person-days for functional and performance testing
3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

- A.** Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, un-degripped, domestic sanitary sewage.

2.2 PERFORMANCE REQUIREMENTS

- A.** Refer to the Pump Data Sheet at the end of this section for performance requirements.

B. Reprime performance

1. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.
2. Pump reprime performance shall be as required in the Supplemental Pump Data Sheet. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:
 - a. A check valve to be installed down stream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.

- b. A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.
- c. The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90 degree elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.
- d. Impeller clearances shall be set as recommended in the pump service manual.
- e. Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
- f. Liquid to be used for reprime test shall be water.
- g. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

2.3 MATERIALS OF CONSTRUCTION

- A. Casing: Pump casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:
 - 1. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.
 - 2. Fill port coverplate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.
 - 3. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.
 - 4. Liquid volume and recirculation port design shall be consistent with performance criteria listed at the end of this section.
- B. Coverplate: Coverplate shall be cast iron Class 30. Design must incorporate following maintenance features:
 - 1. Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.
 - 2. A replaceable wearplate secured to the coverplate by weld studs and nuts shall be AISI 1015 HRS.
 - 3. In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75 – 200 psi.
 - 4. Two O-rings of Buna-N material shall seal coverplate to pump casing.

5. Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.
 6. Easy-grip handle shall be mounted to face of coverplate.
- C. Rotating Assembly: Rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:
1. Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.
 - a. The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.
 - b. The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.
 - c. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.
 2. Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.
 3. Shaft shall be AISI 4140 alloy steel.
 4. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.
 5. Shaft seal shall be cartridge oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton; cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.
 6. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

- D. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.
 - 1. Clearances shall be maintained by a four point external shimless coverplate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.
 - 2. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above.
 - 3. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.
- E. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.
- F. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

2.4 CONTROLS

- 1. Pump controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.

2.5 MOTOR

- A. The requirements of Section 11100 – Pumps, General, apply to this section.
- B. Pump motor shall be as required in the Supplemental Pump Data Sheet.
- A. Each pump shall be driven by an existing variable frequency drive. Contractor shall coordinate between the pump and drive manufacturers/suppliers to ensure compatibility.

2.6 SPARE PARTS

- A. 1 set special tools (as required for pumping unit disassembly)
- B. The following spare parts shall be provided with each pump:

1. 3 sets of all gaskets and O-rings
2. 3 sets of all wear rings
3. 3 sets of all pump shaft bearings
4. 3 sets of mechanical seals
5. 3 sets of shaft sleeves, keys, nuts and accessories
6. 1 set of special tools (as required for pumping unit disassembly)

2.7 PROTECTIVE COATING

1. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.8 MANUFACTURERS

- A. The pump manufacturer shall have a minimum of 1,000 heavy-duty vertical non-clog pumps of similar size and service installed and operating for no less than five years in the United States.
- B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the pump. Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same manufacturer.
- C. Manufacturers or Approved Equal:
 1. Gorman-Rupp.
 2. Wemco.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Refer to Section 11100 Pumps General for delivery and storage requirements.

3.2 INSTALLATION

- A. Refer to Section 11100 Pumps General for installation requirements.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650 Facility Startup. All pump testing shall be in accordance with Section 11100 Pumps General.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are part of this Specification.

1. EQ Return Pump Data Sheet
2. UW Pump Data Sheet

END OF SECTION

PUMP DATA SHEET
SELF-PRIMING PUMPS
EQ RETURN PUMPS NO. EQ-PMP1, EQ-PMP2

Project:	Treatment and Wet Weather Upgrade Project	Manufacturers	
Owner:	Sausalito Marin-City Sanitation District	A.	Gorman-Rupp
Service:	Primary Influent/Effluent	B.	Wemco
Pump Name:	Equalization Pumps		Or Equal
Eqpt. Tag Nos.	EQ-PMP1, EQ-PMP2		
Quantity:	Two (2)		
Operating Conditions		Service Conditions	
Liquid Temperature °F	Normal: Max: Min:	Ambient Temperature (°F)	Normal: 67° Max: 100° Min: 30°
Specific Gravity	1.0 at 60 °F	Altitude (ft)	Sea Level
Vapor Pressure(psia)		Environment	Outdoors
Viscosity at 25 °C		Relative Humidity	40% - 100%
pH		Duty	Continuous

Performance Requirements					
	Design Point 1 – Design Flow at Full Speed	Design Point 2 – Shutoff at Full Speed	Design Point 4 – Design Flow at Approx. 90% of Full Speed	Design Point 5 – Design Flow at Approx. 85% of Full Speed	Design Point 5 – Runout at Full Speed
Design Flow Capacity (gpm), Normal	1389	0	1389	1389	2375
Design Pump Head, TDH (ft)	58	95	48	43	32
Minimum Efficiency (%)	62	-	63	65	50
Minimum NPSH Available (ft)	6	-	16	6	-
Maximum Pump Speed (rpm)	1170	1170	1170	1170	1170
Repriming Lift (ft)	21	-	20	17	-

Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	8	75	Horizontal
Discharge	8	75	Vertical
Seal Type	Mechanical		

Motor Data			
Min. Motor Horsepower:	40	Voltage:	460
Speed (rpm):	1800	Phase:	3
Enclosure Type:	TEFC	Service Factor at rated max. ambient temperature:	1.15
Mounting Type	Horizontal		
Drive Type	VFD. Operating Speed Range: 100 to 50% of Rated Speed.		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
Note			

PUMP DATA SHEET
SELF-PRIMING PUMPS
UTILITY WATER PUMPS NO. UW-PMP1, UW-PMP2, UW-PMP3

Project:	Treatment and Wet Weather Upgrade Project	Manufacturers	
Owner:	Sausalito Marin-City Sanitation District	A.	Gorman-Rupp
Service:	Utility Water	B.	Wemco
Pump Name:	Utility Water Pumps		Or Equal
Eqpt. Tag Nos.	UW-PMP1, UW-PMP2, UW-PMP3		
Quantity:	Three (3)		
Operating Conditions		Service Conditions	
Liquid Temperature °F	Normal: Max: Min:	Ambient Temperature (°F)	Normal: 67° Max: 100° Min: 30°
Specific Gravity	1.0 at 60 °F	Altitude (ft)	Sea Level
Vapor Pressure(psia)		Environment	Outdoors
Viscosity at 25 °C		Relative Humidity	40% - 100%
pH		Duty	Continuous

Performance Requirements			
	Design Point 1	Design Point 2	Design Point 3
Design Flow Capacity (gpm), Normal	220	0	240
Design Pump Head, TDH (ft)	220	237	220
Minimum Efficiency (%)	61	-	63
Minimum NPSH Available (ft)	20	-	18
Maximum Pump Speed (rpm)	2200	2260	2230
Repriming Lift (ft)	2	2	2

Pump Construction Details			
	Size, inch	Rating, psi	Location
Suction	3		Horizontal
Discharge	3	103	Vertical
Seal Type	Mechanical		

Motor Data			
Min. Motor Horsepower:	30	Voltage:	460
Speed (rpm):	1800	Phase:	3
Enclosure Type:	TEFC	Service Factor at rated max. ambient temperature:	1.15
Mounting Type	Horizontal		
Drive Type	VFD. Operating Speed Range: 100 to 50% of Rated Speed.		
Manufacturer: For multiple units of same type of equipment, furnish motors and accessories of a single manufacturer			
Note			

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SECTION 11320 – HYDRAULIC GRIT SYSTEM

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one hydraulic grit removal system capable of passing 13 mgd, with related supports, covers, and equipment. The grit removal mechanism shall be all-hydraulic, self-activating and shall not require internal moving parts and shall be designed to selectively remove grit particles and other inert materials from treatment plant influent.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 – Submittals, CONTRACTOR shall submit the following:
 - 1. Manufacturer's descriptive literature.
 - 2. Dimensioned shop drawings.
 - 3. Mounting support details.
 - 4. Certified performance data, based on tests of similar capacity equipment.
 - 5. Field test data from two (2) existing installations with similar capacity equipment, demonstrating compliance with the performance requirements of this specification.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal

tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. NOT USED
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 2 person-days for functional and performance testing
3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – GRT-EQP1

- A. General – The grit removal unit shall be all-hydraulic and self-activating consisting of self-cleaning corrosion resistant, non-metallic trays with no moving parts. All flow passages shall be self-cleaning and free of sharp projections of fittings that may snag stringy or fibrous material.
- B. The grit removal unit shall be placed in a concrete tank and receive screened plant influent. The grit unit shall provide sufficient surface area to remove the specified grit particles from the specified peak flow and concentrate the grit in a sump at the bottom of the unit. De-gritted effluent shall be weir discharged as shown on the Drawings.

- C. The grit system shall operate on plant utility water continuously supplied to the solids underflow sump at 11 gpm at 50 psig. A rotameter with isolation valves shall be provided and installed near the utility water connection for the grit system.

2.2 PERFORMANCE REQUIREMENTS

- A. The hydraulic grit system shall meet the following requirements:

Criteria	Value
Instantaneous peak flow/unit	13.0 mgd with no more than 12 inches of headloss
Dry weather peak day flow/unit:	4.0 mgd with no more than 1 inch headloss
Average dry weather day flow/unit	1.3 mgd with no more than 1 inch headloss
Diameter	9 feet
Number of trays per unit:	12
Surface area/unit	763 ft ²
Peak surface loading rate	12.7 gpm/ft ²
Performance	- Performance: 95% removal of all grit (specific gravity 2.65) greater than or equal to 110 microns at instantaneous peak flow - Performance: 95% removal of all grit (specific gravity 2.65) greater than or equal to 106 microns at 12.9 mgd - Performance: 95% removal of all grit (specific gravity 2.65) greater than or equal to 75 microns at 4.0 mgd
Grit Underflow Connection diameter	4 inch
NPW connection	1-inch NPT

2.3 MATERIALS OF CONSTRUCTION

- A. General: Materials employed in the equipment shall be suitable for the intended application; materials not specifically called for 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.
- B. The support structure, inlet duct and underflow connection shall be made of type 316 stainless steel.
- C. Trays shall be constructed with a minimum ¼ inch thick LDPE on the pans and sidewalls. The stack of trays shall securely fit into a stainless steel support frame. The support frame shall fit and secure to the bottom of the CONTRACTOR supplied concrete support structure.
- D. A collector made of type 316 stainless steel shall be provided with the grit removal unit for collection and removal of settled solids to the grit washer. The grit collector shall be

installed in the CONTRACTOR supplied concrete tank and incorporate the flanged underflow and threaded fluidizing pipe connections.

2.4 NOT USED

2.5 PROTECTIVE COATING

- A. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.6 MANUFACTURERS

- A. MANUFACTURER's Experience: The contractor shall provide products which have at least 5 years in operation. No equipment shall be considered which has an operating history of less than 5 years. Manufacturer shall have a minimum of 10 units in operation in the U.S. for a minimum of 3 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The screen manufacturer shall be responsible for all equipment provided under this section.
- C. Manufacturers, No Equal:
 - 1. Hydro International.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. Installation of the grit chamber equipment shall be in strict accordance with the requirements of the manufacturer's written instructions, provided that nothing in said instructions shall authorize the CONTRACTOR to vary from the requirements of the Contract Documents.
- B. The equipment shall be field painted after shop priming, in accordance with Section 09960, Protective Coatings.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650 Facility Start Up.
- B. NOT USED
- C. Functional Testing

1. Upon completion of the installation, each piece of equipment and each system shall be tested for satisfactory operation without excessive noise, vibration, overheating, etc. All equipment shall be adjusted and checked for misalignment, clearances, supports, and adherence to safety standards.

D. Performance Testing

1. The test shall be conducted to determine the ability of the furnished and installed grit removal system to meet the specified grit removal efficiencies at the specified unit flow rate. In submitting a bid, the Bidder accepts the test procedure as a valid basis for determining the ability of the grit removal system to meet the specified performance. In the event that the equipment furnished fails to meet the specified grit removal efficiency, the equipment shall be modified at the Supplier/ CONTRACTOR's sole expense as required until the specified removal efficiencies are met. If subsequent grit removal system operational tests are required by the District after modifications are made, all costs for these tests as well as all costs for any necessary modifications to the grit removal system shall be borne by the CONTRACTOR.
2. Grit Removal Efficiency Testing:
 - a. At the DISTRICT'S sole discretion, the DISTRICT shall conduct third party testing to confirm the installed grit equipment complies with the grit removal requirements of this specification. The DISTRICT may begin the third party testing anytime within 365 days of substantial completion. Costs for third party testing shall be paid by the DISTRICT. In submitting a bid, the Bidder accepts the DISTRICT'S third party testing as a valid basis for determining the ability of the grit removal system to meet the specified performance.
 - b. In the event that the equipment furnished fails to meet the specified grit removal efficiency, the equipment shall be modified at the Supplier/ CONTRACTOR's sole expense as required until the specified removal efficiencies are met. If subsequent grit removal system operational tests are required by the DISTRICT after modifications are made, all costs for these tests as well as all costs for any necessary modifications to the grit removal system shall be borne by the CONTRACTOR.

PART 4 SCOPE OF SUPPLY AND VENDOR QUOTE

END OF SECTION

PART 4 - SCOPE OF SUPPLY AND VENDOR QUOTE



Bid Pricing			
Project Name:	Sausalito-Marin City Sanitary District, CA	Date Prepared:	December 14, 2016
Project Number:	13-3139	Validity:	See Scope
Representative:	MISCOwater	Engineer:	RMC
Equipment		Quantity	Price
Primary Grit Removal 13.0 mgd/unit			
9 ft. 12 Tray 110 micron Eutek HeadCell® Grit Removal unit		1	
Eutek HeadCell® inlet flow distribution header, 316 Stainless Steel		1	
Grit slurry underflow collector, 316 Stainless Steel		1	
Extended Warranty		1	
Equipment Subtotal			<u>\$147,300.00</u>
Freight			
Freight to jobsite in Sausalito, CA		1	<u>\$7,500.00</u>
Start-up			
One (1) factory representative for three (3) trips for a total of four (4) days		1	<u>\$7,200.00</u>
Total Bid Price:			<u>\$162,000.00</u>

Terms & Conditions: As defined by Hydro International standard Terms & Conditions.



12/14/2016

To: RMC Water and Environment

**Re: Hydraulic Grit System – Section 11320
Sausalito-Marín City Sanitary District
Sausalito, CA
File #13-3139**

Hydro International is pleased to present our quote for a Eutek HeadCell® Grit Removal System. The system will meet the requirements described in Section 11320 with comments noted below.

Comments / Exceptions

1. 1.4.A.3. & 3.3.B. The HC will be inspected for alignment of components and correct orientation before being shipped, it will not be factory performance tested prior to shipping as each unit requires a specific concrete tank which is not feasible at our fabricators.
2. 1.4.A.6. & 2.4.A. No recommended spare parts for the HeadCell unit.
3. 3.3.D.1. Performance testing will be conducted by others.
4. M100-3. The HeadCell fluidizing line and underflow suction pipe must be in the same orientation as the influent of the unit (counterclockwise).
5. M100-5. If grating is not easily removable, please provide 3'x3' access hatches in grating for access to the HeadCell, one in the center of the tank, one above the inlet duct, and one in the opposite diagonal corner of the inlet duct.
6. I100-1. Hydro does not recommend a solenoid valve on the 1" fluidizing line as the fluidizing line should only be shut off when the HeadCell is taken out of service.
7. Velocity through the bar screen openings/slots/aperture should not exceed 4 ft/s at peak flow.
8. All piping connected to Hydro equipment must be supported by other means than the Hydro equipment.
9. The dumpster receiving the discharged grit shall have a drain.
10. Please see the exclusions detailed in the proposal below.

System Performance

The grit removal system shall be designed to remove 95% of all grit particles with specific gravity of 2.65 greater than or equal to 110 microns at a total peak design flow of 13.0 mgd.

System Components

1. One (1) 9' 12 tray Eutek HeadCell® Grit Concentrator unit shall be supplied. The Eutek HeadCell® shall consist of a stack of nested trays. The trays shall be fabricated from UV stabilized LDPE and shall be supported by a 316 SS frame integral to the unit. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials. The Eutek HeadCell® trays shall be constructed with a minimum ¼ inch material pans and sidewalls. The Tray Supports shall be fabricated to provide a means to independently support each tray and transfer the weight of each tray to the support structure frame. The Eutek HeadCell® will securely fit into a support structure frame containing the screened raw wastewater inlet connection, necessary hardware, and connections. The Eutek HeadCell® Concentrator shall be equipped with a settled solids underflow connection for collection and removal of settled solids. The settled solids are pumped to the grit washing unit from the Eutek HeadCell® unit.

The unit shall remove 95% of all grit (S.G. 2.65) 110 micron and larger at a peak flow of 13.0 mgd.
The unit shall have 12 inches of headloss at the peak flow.

Utility Requirements

Clarified NPW or Reuse Water:

The Eutek HeadCell® unit requires continuous 11 gpm @ 50 +/- 10 psig of clarified water for “fluidizing” to function properly.

Appurtenances Per Unit

Eutek HeadCell® Grit Concentrator

DESCRIPTION	QTY
Fluidizing Water Throttling Globe Valve 1" Ta Chen Globe Valve, Stainless Steel	1
Fluidizing Water Shut-off Valve 1" Apollo Ball Valve, Stainless Steel	1
Fluidizing Water Flow Meter 1" King Flow Meter, Stainless Steel	1

Spare Parts

No spare parts are included or recommend in this scope of supply.

Start-up

One (1) man, three (3) trips, for start-up and instruction services as required totaling four (4) days.

Exclusions

Any item(s) not specifically described above are excluded and are not to be supplied by Hydro International including but not limited to the following:

- Erection and installation
- Interconnecting piping and valving not expressly stated above
- Pipe connections and fittings not expressly stated above
- All pipe supports, hangers and braces
- Controls, switches, control panels and instrumentation of any kind not expressly stated above
- Wiring and conduit
- Field or touch-up paint, painting, blasting and touch-up of surface finish
- Spare parts not specifically stated above
- Unloading, hauling and storage charge
- Lubricating oil and greases
- Field performance testing, laboratory testing
- and sample collection and analysis
- All concrete and grouting work
- Insulation and heat tracing of any kind
- Seismic/Structural analysis
- Performance and/or Supply Bond(s)
- Dumpsters of any kind
- Grit pump(s)/pump motor starters/VFD, associated piping, guiderails and valving, gauges
- Access platforms, walkways, ladders, covers
- Anchor bolts
- Grit Study
- Metal or rubber extended discharge chutes
- Translation Services
- Asset Management Contract

Limitations

- General Liability is limited to \$5,000,000 per each occurrence

- Products Completed & Operations Liability is limited to \$5,000,000 per each occurrence
- Worker's Compensation is limited to \$5,000,000 per each accident

Warranty

Hydro International's 2-year Warranty shall apply per the attached Terms and Conditions of Sale.

Delivery

Please allow 4 to 6 weeks after receipt of purchase order for approval drawings. Shipment is typically a maximum of 16 weeks after receipt of "Approved" or "Approved As Noted, Resubmittal Not Required" submittal package. The grit removal system shall be delivered to site fully fabricated, subject to size, packaging and transportation constraints. The General Contractor must inspect equipment prior to unloading and notify Hydro International of any damage to equipment within 5 days to effect proper remedial action. Failure to notify Hydro International of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

Terms & Conditions

Hydro International payment terms are detailed in the attached terms and conditions. The pricing submitted herein is based on specification sections and drawings issued to Hydro on November 29, 2016 via MISCOwater. Any changes to the scope of supply required by changes to these specification sections or other sections and drawings not provided to Hydro International as listed above may require the price to change. Hydro International reserves the right to amend the price if changes are required due to changes to the provided specifications or to meet requirements for sections not made available at the time of this quote. Price includes truck freight to jobsite and does not include any state or local taxes if required. The prices quoted are firm based on a receipt of a purchase order by April 27, 2017 and shipment of the equipment prior to October 12, 2017.

Purchase Order

Please make purchase orders to:
Hydro International
2925 NW Aloclek Drive
Suite #140
Hillsboro, OR 97124

Local Representative

Mr. Mark Humberstone
MISCOwater
5976 W. Las Positas Blvd. Ste 226
Pleasanton, CA 94588
Phone: 925-785-1602
Fax: 925-225-9200
mhumberstone@miscowater.com

If you have any questions or concerns, do not hesitate to contact me.

Regards,

Hydro International



Kelly Rini
Applications Engineer

Standard Terms & Conditions of Sale

1. **DEFINITIONS.** "Hydro" is Hydro International with an address of 2925 NW Alcock Drive #140 in Hillsboro, Oregon. "Buyer" is the party purchasing the goods from Hydro.
2. **ENTIRE AGREEMENT.** Hydro's agreement is based on these terms and conditions of sale. This document, together with any additional writings signed by Hydro, represents a final, complete, and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained, or waived by parol evidence, Buyer's purchase order, any course of dealing, Buyer's payment or acceptance, or in any other way except in writing signed by Hydro through its authorized representative. These terms and conditions are intended to cover all activity of Hydro and Buyer hereunder, including sales and use of products, parts, and work, and all related matters (references to products include parts and references to work include construction and installation). Hydro's obligations hereunder are expressly conditioned on Buyer's assent to these terms and conditions. Hydro objects to any terms that are different from, or additional to, these terms and conditions. Any applicable detail drawings and specifications are hereby incorporated and made a part of these Terms and Conditions of Sale insofar as they apply to the material supplied hereunder.
3. **SPECIFICATIONS.** Products are supplied in accordance with information received by Hydro, or its duly authorized agent, from Buyer. Hydro shall have no responsibility for products created or sold based upon inaccurate and/or incomplete information supplied to it. Buyer shall ensure that Hydro receives all relevant information in time to enable it to supply the appropriate products.
4. **INSTALLATION AND APPLICATION OF PRODUCTS.** Products supplied hereunder shall be installed and used only in the particular application for which they were specifically designed. Buyer should not presume that any products supplied by Hydro may be utilized for any applications other than those specified; nor shall Hydro's obligations, including, without limitation, any warranty obligations, survive Buyer's transfer of products supplied hereunder to third parties unless the products are transferred with Hydro's consent. In addition, Buyer shall not use any product supplied hereunder at any location other than at the location for which Hydro has previously received notice from Buyer. Any breach of any of the foregoing restrictions may amount to an infringement of the patent for the products in question and will in any event void all express or implied warranties relating to the products supplied hereunder.
5. **PURCHASE PRICE AND PAYMENT TERMS.** All prices are in U.S. dollars and all payments shall be made in U.S. dollars. Payment terms are as follows:

	Incremental Payment	Cumulative Payment
Upon Approval of Shop Drawings	10%	10%
Upon Delivery of Equipment to Site	80%	90%
Upon Final Acceptance or 45 days following completion of equipment start up	10%	100%

If payments are not made in conformance with the terms stated herein, any unpaid balance shall be subject to interest at a rate 1½% per month, but not to exceed the maximum amount permitted by law. If shipment is delayed by Buyer, the previously agreed date of readiness for shipment shall be deemed to be the date of shipment for payment purposes. If manufacture is delayed by Buyer, a payment shall be made based on purchase price and percentage of completion, with the balance payable in accordance with the terms as stated. If at any time in Hydro's judgment Buyer may be or may become unable or unwilling to meet the terms specified, Hydro may require satisfactory assurance or full or partial payment as a condition to commencing, or continuing manufacture, or in advance of shipment.

Until payment in full has been received by Hydro, this Standard Terms and Conditions of Sale shall constitute a security agreement and Buyer hereby grants Hydro a purchase money security interest in and to the products produced by Hydro hereunder, and any products or proceeds thereof. In particular:

- (i) Hydro will retain an express purchase money security interest in and to the products and all proceeds thereof.
- (ii) Until full payment for the products is received by Hydro, Hydro reserves the right to retake possession of the products at any time and for this purpose Buyer authorizes Hydro or its duly authorized agent to enter upon land or premises where it believes the product may be.
- (iii) Proceeds of any disposal of the products shall be held in trust for Hydro pursuant to the terms of the Maine Uniform Commercial Code.
- (iv) Buyer grants Hydro a power of attorney for the purpose of filing a UCC-1 financing statement in the name of Buyer to evidence Hydro's security interest in the products.

6. **BACKCHARGES.** In the event that Buyer is required to make repairs, corrections or modifications to the goods supplied by Hydro, it shall only do so upon written approval from Hydro. Backcharges shall be limited to the costs directly associated in making the repairs, corrections or modifications to the goods supplied by Hydro. The costs of such backcharges shall be subject to approval by Hydro and shall be limited to: (1) directly related labor and material costs, (2) directly related equipment and tool rental at prevailing rates in the project location and (3) Buyer's overhead & supervision costs to make repairs, corrections or modifications to the goods supplied by Hydro. Buyer shall submit complete documentation to Hydro's satisfaction including but not limited to labor time sheets, material lists, and rental fees detailing the nature of the back charges. Backcharges shall be in the form of an adjustment to the

contract price or reduction in retained payments and not a direct payment. No incidental or consequential backcharges shall be allowed.

7. **DELIVERY.** The goods are sold F.O.B. manufacturing site, freight prepaid to Buyer at job site. Except as outlined in Paragraph 8 below, the risk of loss passes to Buyer after Hydro delivers the goods to the carrier. Hydro reserves the right to select the method of shipment and carrier. Delivery dates are approximate only and are not a guarantee of delivery on a particular day. Hydro is not liable for failure or delays in deliveries of any cause whatsoever beyond the control of Hydro.
8. **TITLE & INSURANCE:** Title to the product(s) and risk of loss or damage shall pass to Buyer upon delivery to a carrier as outlined in Paragraph 7 above, or, in the event Buyer delays shipment, by the previously agreed date of readiness for shipment, except that a security interest in the product(s) or any replacement shall remain in Hydro's name, regardless of the mode of attachment to realty or other property, until the full price has been paid in cash. Buyer agrees to protect Hydro's interest by adequately insuring the product(s) against loss or damage from any external cause with Hydro named as insured or co-insured.
9. **ERECTION:** Unless otherwise stated in writing, the goods provided hereunder shall be assembled and erected by and at the expense of Buyer.
10. **CANCELLATION & BREACH:** Orders placed cannot be canceled, nor shipments of goods made up, or in process, be deferred beyond the original shipment dates specified, except with Hydro's written consent and upon terms which shall indemnify Hydro against all loss. In the event of cancellation or the substantial breach of Buyer's obligations, as by failing to make any of the payments when due, the parties agree that Hydro will suffer a serious and substantial damage that will be difficult, if not impossible, to measure, both as of the time of entering into this purchase agreement and as of the time of such cancellation or breach. Therefore, the parties agree that, upon such cancellation or breach, Buyer shall pay to Hydro the sums set forth herein below, which sums the parties do hereby agree shall constitute agreed and liquidated damages in such event:
 - If cancellation or breach shall occur after the acceptance of the purchase order but prior to mailing of submittal documents by Hydro to Buyer, liquidated damages shall be 10% of the selling price.
 - If cancellation or breach shall occur within thirty (30) days from the mailing of submittal documents by Hydro to Buyer, the liquidated damages shall be 20% of the selling price.
 - If the cancellation or breach occurs after thirty (30) days from the mailing of submittal documents by Hydro to Buyer, but prior to notification that the order is ready for shipment, the liquidated damages shall be the total of 30% of the selling price plus the expenses incurred, cost of material, and reasonable value of the work expended to fill the order involved herein by Hydro's engineers and other employees, agents and representatives after the mailing of general arrangement drawings by Hydro to Buyer, said sums to be determined at the sole reasonable discretion of Hydro; provided, however, that the total liquidated damages under this provision shall not exceed the total selling price.
 - If cancellation or breach shall occur after Hydro has notified Buyer that the order is ready for shipment, then the liquidated damages shall be the total selling price, less costs associated with startup or field testing.
11. **MATERIALS OF CONSTRUCTION, PAINTS AND COATINGS:** Buyer is responsible for determining the suitability of, and for giving final approval of, the materials of construction, paints, coatings, etc. to be used by Hydro.
12. **WARRANTY:** Any product that proves defective in material, workmanship or design within twenty four (24) months after delivery (or entry into storage) will be, at the discretion of HYDRO, modified, repaired or replaced, or Buyer's payment for the products will be refunded. This shall be Buyer's sole remedy. HYDRO EXPRESSLY EXCLUDES AND DISCLAIMS ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTIES, EXPRESS OR IMPLIED.

This warranty does not cover any defects or costs caused by: (1) normal wear and tear of equipment from designed operation. (2) modification, alteration, repair or service of the goods by anyone other than Hydro; (3) physical abuse to, or misuse of, the goods, or operation thereof in a manner contrary to Hydro's instructions; (4) any use of the goods other than that for which they were intended; (5) chemicals or components which were not disclosed to Hydro; (6) storage contrary to Hydro's instructions; or (7) failure to maintain the goods in accordance with Hydro's instructions.

This warranty does not apply to component parts of the goods that were not both originally designed and manufactured by Hydro, including, but not limited to, valves and controls. These component parts do not carry any warranties by Hydro, and only carry the warranties, if any, of their manufacturers.

In order for Buyer to make a claim under this warranty, Buyer must promptly, and within the warranty period, notify Hydro in writing of any defect(s) in the goods covered by this warranty. If any defect(s) in the goods covered by this warranty are visible at the time of delivery, Buyer must notify Hydro of the defect(s) in writing within five working days. To make any claim under this warranty, Buyer must also fully comply with written authorization and return instructions from Hydro.
13. **FIELD SERVICE:** Startup/Field Service will only be scheduled upon written request. Buyer shall notify Hydro of schedule requirements at least ten (10) working days in advance, or additional charges may be added to cover late-scheduled travel costs. Additional costs will be limited to those arising out of late-scheduled costs. Should Buyer have outstanding balances due Hydro, no startup / field service will be scheduled until such payments are received by Hydro. Hydro will send documents to Buyer defining the service or startup requirements. Buyer assumes all responsibility for the readiness of the system when it requests startup service. Should Hydro's Field Service Engineer arrive at the jobsite and determine that the system cannot be started up within a reasonable time, Hydro shall have the option to bring the Field Service Engineer home and bill Buyer for time, travel and living expenses. Additional field service is available from Hydro at the prevailing per-diem rate at the time of the request for service plus all travel and living expenses, portal-to-portal. A purchase order or change order will be required prior to scheduling this additional service.

- 14. LIMITATION OF HYDRO'S LIABILITY.** Hydro assumes no liability or responsibility for the misuse of its products by Buyer, Buyer's employees, agents or assigns, or other use inconsistent with the use appropriate to the performance specification requirements submitted to Hydro, and Buyer agrees to indemnify and hold harmless Hydro for any loss, costs, expense or liability that it may incur or be put to as a result of misuse or inconsistent use of the products. In addition, Hydro shall have no liability to Buyer for any consequential or incidental damages incurred by Buyer in connection with the contract documents or the products purchased by Buyer. Hydro shall not be liable for any loss which results from delay in delivery caused by any reason beyond its control, including, but not limited to, acts of God, casualty, civil disturbance, labor disputes, strikes, transportation or inability to obtain materials or services, any interruption of its facilities, or act of any governmental authority. The time for delivery shall be extended during the continuance of such conditions. The total liability of Hydro to Buyer in the form of liquidated damages for any loss, indemnity, damage or delay of any kind will not under any circumstances exceed 25% of the Contract Sum.
- 15. INTELLECTUAL PROPERTY.** Hydro shall retain sole ownership of all of its intellectual property used or produced in connection with the Project, including but not limited to all drawings, specifications, software, written materials, manuals, marks, business methods, and all other property that is capable of protection by a patent, copyright or trademark (whether or not such protection has actually been sought). Buyer shall not use such intellectual property except for the purpose of confirming the quality of design and/or manufacturing of the products and services set forth in the Proposal. Buyer shall not photocopy, duplicate or in any way copy such intellectual property except for the Buyer's internal purposes only (but not for rendering services or selling products to third persons). Buyer shall not sell, license, assign or transfer the intellectual property protected by this paragraph to anyone. Buyer shall ensure that Owner is in possession of valid licenses for all third-party software (not provided by Hydro) used for the Project, and shall indemnify and hold harmless Hydro against all claims by licensors of such software. Hydro makes no warranty regarding the effect of such third-party software on the performance of the software to be developed by Hydro for the Project and Hydro shall be released from any warranties given to Buyer to the extent that such software causes or contributes to problems. Following acceptance and final payment to Hydro, Hydro will grant to the Owner a non-transferable, non-exclusive license to use the software for the Owner's internal purposes only in the form of the license agreement attached as Exhibit A.
- 16. TAXES.** Prices stated herein do not include any tax, excise, duty or levy now or hereafter enacted or imposed, by any governmental authority on the manufacture, sale, delivery and/or use of any item delivered. An additional charge will be made therefore and paid by Buyer unless Hydro is furnished with a proper exemption certificate relieving Hydro of paying or collecting the tax, excise, duty or levy in question.
- 17. INTERPRETATION OF CONTRACT.** This contract shall be construed according to the laws of the State of Maine.
- 18. CHOICE OF FORUM.** Buyer and Hydro hereby consent and agree that the United States District Court for the District of Maine or the District Court or Superior Court located in the City of Portland, County of Cumberland, Maine will have exclusive jurisdiction over any legal action or proceeding arising out of or relating to the contract documents, and each party consents to the personal jurisdiction of such Courts for the purpose of any such action or proceeding. Buyer and Hydro further hereby consent and agree that the exclusive venue for any legal action or proceeding arising out of or relating to the contract documents will be in the County of Cumberland, Maine. Each party hereby waives all rights it has or which may hereafter arise to contest such exclusive jurisdiction and venue.
- 19. ATTORNEYS' FEES.** If any judicial or non-judicial proceeding is initiated for the purpose of enforcing a provision of this contract, the prevailing party shall be awarded reasonable attorneys' fees in addition to all other costs associated with the proceeding, whether or not the proceeding advances to judgment.
- 20. SEVERABILITY.** If any provisions of this contract are held invalid by a court of competent jurisdiction, the remainder of this contract shall not be rendered invalid, and such invalid provisions shall be modified, in keeping with the letter and spirit of this contract, to the extent permitted by applicable law so as to be rendered valid.
- 21. ANTI-BRIBERY.** Hydro International will not engage in any form of bribery or corruption. The offering, giving or receiving of bribes is contrary to Hydro International's values and can play no part in the way in which it carries out its business. Hydro requires you to support our approach and implement provisions consistent with our policy through your own organization and your supply chain. Please find a copy of our Anti-Bribery and Corruption Policy on our website at <http://plc.hydro-intl.com/content/view/296/247/>

SECTION 11325 – GRIT WASHER

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish, install, and place into satisfactory operating condition one (1) grit washer for removing, washing and conveying grit particles before discharging the material into a dumpster as shown on the drawings and described in the following specification section. The CONTRACTOR shall provide all appurtenant work including all structural frames, tools, spare parts, mounting brackets, piping, controls, safety equipment, and all appurtenances for a complete and operational unit as specified herein, in accordance with the requirements of the Contract Documents.
- B. Layout is based on the A-listed MANUFACTURER. The arrangement of piping and equipment and foundations indicated on the Drawings may be modified as necessary for the specific model of grit washer provided. The cost of all modifications, including design services and DISTRICT and ENGINEER time for review and approval, shall be the responsibility of the CONTRACTOR at no increase in cost to the DISTRICT. The ENGINEER shall review the proposed modification to the original design and shall be the sole judge as to type, function, and quality of the modification.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 Submittals.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Manufacturer's descriptive literature.
5. Dimensioned shop drawings.
6. Mounting support details.
7. Certified performance data, based on tests of similar capacity equipment.
8. Field test data from two (2) existing installations with similar capacity equipment, demonstrating compliance with the performance requirements of this specification.
9. Special shipping, storage and protection, and handling instructions
10. MANUFACTURER's printed installation instructions
11. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
12. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 1 person-days for functional and performance testing
3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – GC-EQP1

2.2 PERFORMANCE REQUIREMENTS

- A. Design flow of grit slurry from grit trap per unit: 250 gpm, continuous
- B. At the specified design flow, the efficiency of the grit washer shall be as follows:
 - 1. Grit processing capacity per unit: 1.5 ton/hr
 - 2. Maximum water content in washed grit product: 10%. All vegetable matter within the sample shall remain and be included as part of the test.
 - 3. Maximum volatile solids content in dried grit product at design flow: 5%. All vegetable matter within the sample shall remain and be included as part of the test.
 - 4. Capture rate of 100 micron and larger quartz sand at design flow: 95%
- C. Grit Washer(s) shall be capable of washing material containing grit, and possibly other settleable solids including vegetable matter, cigarette butts, popsicle sticks, rags etc, without plugging problems and loss of performance stipulated herein.
- D. Grit discharged to dumpster for disposal shall be clean with solids containing no visible fecal matter, and shall be free of putrescible odors.

2.3 MATERIALS OF CONSTRUCTION

- A. General: Unless otherwise specified in these specifications, the entire equipment shall be manufactured from type 316 stainless steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the O&M manual.
 - 1. The equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion in accordance with ASTM A380. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.
- B. Grit Washer Tank
 - 1. The tank shall have flanged inlet and outlet connections as shown on the Contract Drawings and shall be designed for a free discharge over an outlet weir.

- i. The outlet connections shall be located 45 degrees counter clockwise from the grit screw as shown on the Contract Drawings. The grit tank inspection hatch shall be located above the outlet connections.
2. The tank shall be constructed of a min. 5/32" thick, type 316 stainless steel and shall be designed by the manufacturer to withstand all applicable seismic, process and structural loads and provide support of all components attached to the tank (such as the drive assembly).
3. Drain Connection. A 4 inch drain connection with ball valve shall be supplied by the grit manufacturer as shown in the Contract Documents. It shall be routed to a drain as shown on the Contract Documents.
4. A 110VAC, single phase, electrically operated actuator shall be provided to provide automatic control of the ball valve and shall be suitable for a Class 1 Division 1 Classification if it is located within 18 inches of the top of the equalization basin.
5. A 110VAC, single phase, pressure probe shall be mounted in the bottom of the grit settling area to monitor the grit level within the tank and to control the operation of the grit stirrer and grit removal screw. The pressure probe shall be suitable for a Class 1 Division 1 Classification if it is located within 18 inches of the top of the equalization basin.

C. Grit Screw

1. The grit screw shall dewater and convey the grit above the level of the overflow weir. Washed and dewatered grit shall be discharged at the upper end of the screw into a dumpster.
2. The inlet hopper shall be flange-connected to the grit discharge tube. The screw shall have a discharge height of 117 inches above the floor. Its inlet hopper shall be provided with a 3" diameter (DN 80) drain connection that is provided with a ball valve. The drain connection shall also be provided with a 1" flush connection with ball valve.
3. The grit screw shall be shafted and shall be made of type 316 stainless steel.
4. The screw conveyor trough shall consist of a minimum 5/32 inch type 316 stainless steel.

D. Fluidized Grit Bed

1. Up to 22 gpm of plant utility water at 29 psi shall be provided at the bottom of the grit bed at a location recommended by the grit washer manufacturer.
2. The utility water shall ensure proper fluidization of grit accumulated at the bottom of the hopper, to loosen up settled materials and keep organics in suspension while removing the settled grit via the grit screw.
3. The wash water manifold will be provided with a variable area flow meter to allow visual inspection of the internal float for manual flow rate confirmation.

4. The following equipment shall be supplied by the grit washer manufacturer to control fluidization water:
 - a. One (1) 1.25 inch diameter brass body solenoid valve, which shall be explosion proof or intrinsically safe and shall comply with a Class 1 Division 1 hazard area classification if located within 18 inches of the top of the equalization basin.

2.4 CONTROLS

- A. General: The control package, complete with all components specified herein, shall be provided by the grit chamber manufacturer and shall provide for total automatic operation with protection against overload conditions.
- B. Controls shall be supplied per Section 13400 Instrumentation and Control Systems and Section 13475 Control Strategies.
- C. The intent is that the Contractor provides power and control wiring, as required, to the manufacturer supplied control panel, and from the control panel to the junction boxes mounted on the equipment.
- D. The manufacturer shall provide all control components, wiring, conduits and supports, interconnection wiring of proper size, and all other electrical items required for connecting all grit manufacturer supplied equipment, motors, instruments hand switches etc that are associated with the equipment and shall route this wiring to junction boxes mounted on the grit equipment. The junction boxes, and all associated mounting hardware shall also be supplied by the manufacturer.
- E. In order to minimize electrical and controls field coordination, the Contractor shall provide all control components, field wiring, conduits and supports, interconnection wiring of proper size, and all other electrical items required to connect from the grit manufacturer supplied control panel to the grit manufacturer supplied junction boxes on the grit equipment.
- F. All wiring and electrical and controls equipment shall comply with a Class 1 Division 1 Classification within 18 inches of the top of the equalization basin.
- G. Controls: Controls shall be housed in enclosures with NEMA ratings which comply with the area designations of Section 16000 – Electrical – General Provisions.
- H. The power supply shall be 460 volts, 3 phases, 60 hertz.
- I. The electrical control system shall provide for automatic control of the grit washer via a signal from the feed pump control panel.
- J. Control Panel
 1. The manufacturer shall supply a prewired control panel. The control panel shall be stanchion mounted to the platform as shown on the Contract Documents.
 2. Main control panel shall be suitable for outdoor, wall-mounting. Enclosure shall be NEMA 4X Stainless Steel with continuous hinge and shall include the following:

- a. Door-interlocked and fused disconnect
- b. 600 VAC terminal block
- c. NEMA motor starter and Circuit Breaker Branch Circuit Protection for grit screw motor
- d. NEMA motor starter and Circuit Breaker Branch Circuit Protection for grit stirrer motor
- e. Control power transformer with 120 VAC transient voltage surge compressor (TVSC) and fused primary and secondary
- f. Programmable logic controller (PLC)
- g. Operator Interface (OIU)
- h. Pilot lights for:
 - 1) Control power on (white)
 - 2) Grit Screw running (green)
 - 3) Grit Stirrer (green)
 - 4) Organic Valve open (green)
 - 5) Grit Screw fault (red)
 - 6) Grit Stirrer fault (red)
 - 7) Organic valve fault (red)
- i. E-stop push button (red)
- j. Grit Washer reset push button (black)
- k. Door mounted elapsed time meters for the following:
 - 1) Screw drive
 - 2) Stirrer drive
- l. Remote dry contact input for the following:
 - 1) Machine start
 - 2) One spare input
- m. Remote dry contact outputs for the following:
 - 1) Grit washer running
 - 2) Grit Washer fault
 - 3) Grit Washer E-stop
 - 4) One spare output
- n. Flashing alarm light and alarm horn with silencer-reset button
- o. Plastic Nameplates

- K. The Control Panel shall have the capability to communicate with the Plant SCADA system via a MODBUS TCP communication port. Any and all control and monitoring signals from the field to the Grit Washer Control Panel shall be available to the Plant SCADA system via this communication port. The control panel shall have internal Programmable Logic Controller capable of communication to the Plant SCADA PLC.

2.5 MOTOR

A. Grit Screw

- 1. The drive unit shall be directly coupled to the grit conveying screw drive shaft.
- 2. The motor shall be constant-speed, premium efficiency, min 1.5 hp, 1760 rpm, TEFC, induction type, 1.0 service factor, 460 volt, 3 phase, 60 Hertz. The motor shall be designed to prevent overload under normal operating conditions and shall

comply with the requirements of Section 16222 – Motors, and shall be suitable for a Class 1 Division 2 Classification within 18 inches of the top of the equalization basin.

B. Grit Stirrer

1. The motor shall be constant-speed, premium efficiency, min 1.0 hp, 1760 rpm, TEFC, induction type, 1.0 service factor, 460 volt, 3 phase, 60 Hertz. The motor shall be designed to prevent overload under normal operating conditions and shall comply with the requirements of Section 16222 – Motors, and shall be suitable for a Class 1 Division 2 Classification within 18 inches of the top of the equalization basin.

2.6 APPURTENANCES, SPARE PARTS AND SPECIAL TOOLS

- A. Nameplate: Each piece of equipment shall be provided with a stainless steel nameplate, indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, and serial number.
- B. Equipment Supports: Grit washer equipment and piping shall be firmly supported on concrete equipment pads and anchored down. All anchor bolts, nuts, and washers of such supports shall be of type 316 stainless steel, with an anti-seize compound on the threads.
 1. The grit equipment supplier is responsible for providing all supports as necessary to meet design, wind and seismic loads and to install the grit equipment on the concrete equipment pad as shown in the Contract Documents.
- C. Safety Equipment: Where required by Code, equipment shall be provided with the necessary safety devices and warning signs, clearly visible.
- D. Tools: Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for the equipment shall be furnished as a part of the Work; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Spare Parts: The Contractor shall obtain from the manufacturer a list of suggested spare parts of all items of each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, bearings, etc. Furnish spare parts suitably packaged and labeled in a box in the same manner as required for tools.
- F. The spare parts shall include, but not limited to:
 1. One (1) perforated diaphragm (membrane)
 2. One (1) complete solenoid valve assembly

2.7 PROTECTIVE COATING

1. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.8 MANUFACTURERS

- A. MANUFACTURER's Experience: The contractor shall provide products which have at least 5 years in operation. Manufacturer shall have a minimum of 15 units in operation in the U.S. for a minimum of 3 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The washer manufacturer shall be responsible for all equipment provided under this section.
- C. Manufacturers or Equal:
 - 1. Huber.
 - 2. Smith & Loveless.
 - 3. Lakeside Equipment Corporation
- D. Any use of substitute equipment shall not relieve the CONTRACTOR of providing a complete and operable system in complete conformance to the specifications, including all performance parameters and interfacing requirements.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. General: Equipment shall be installed in accordance with governing safety standards, manufacturers written recommendations, procedures submitted with the shop drawings, and as indicated on the drawings, unless otherwise approved by the Engineer.
- B. Lubricants: The Work shall include furnishing the necessary oil and grease for initial lubrication and testing of all equipment.

3.3 TESTING

- A. General: Provide testing in accordance with Section 01650 – Facility Start Up and Section 11000 – Equipment General Provisions.
- B. Factory Testing
 - 1. Grit washing equipment shall be factory assembled and factory run tested prior to shipment. The main control panel shall also be factory tested.

2. Certified factory test reports shall be submitted in accordance with ISO-9001.

C. Field Testing

1. Grit washing equipment shall be field tested to verify proper alignment and operation without vibration, jamming, overheating or other defects and that all components perform their specified functions satisfactory.

D. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01650 Facility Start Up.

2. Grit Washing Testing:

- a. Summary

- 1) Manufacturer shall field test installed Grit Washing Equipment to demonstrate compliance with performance requirements specified in section this section. The following physical conditions shall be demonstrated by the grit washer:
 - a) Performance test shall be performed for each grit washer installed.
 - b) Accept pumped design flow, in the case of the grit washer unit this is 250 gpm.
 - c) Produce dry grit with less than 10% moisture content.
 - d) Have no visible fecal matter (less than or equal to 5%) and be absent of putrescent odor.
 - e) Operate reliably without breakdown or stoppage due to blockage at all design conditions. Grit washer(s) shall have completed 120 hr systems demonstration prior to start of performance test. If grit has not yet discharged from unit(s) within one week of performance test, manufacturer shall supply and fill unit(s) with amount of sand recommended in order to create a base and start producing grit. Unit(s) shall operate for one week following addition of supplemental sand prior to start of performance test.
 - f) Require minimal operation and maintenance.
 - g) Performance data will not be evaluated on a combined average of all units tested. Each unit must meet the design requirements.
 - 2) The District shall furnish labor for each sample collection and the manufacturer shall pay cost of laboratory analysis as specified herein, unless otherwise negotiated with District. Performance analysis will be carried out at laboratory approved by the District.

- b. Compliance

- 1) If test results demonstrate that equipment does not conform to requirements of specifications concerning organics residual and percent moisture, manufacturer shall have the opportunity to make improvements at no cost to the District.

- 2) Manufacturer shall perform a second test. If the second test has not successfully passed the organic and moisture performance parameters as specified, the MANUFACTURER shall pay a penalty to the District based on the cost of the grit washing equipment to the CONTRACTOR. The District can reject the grit washing equipment as a whole based first on failure of organic content, if organics content is acceptable then on moisture content as follows:
 - a) Organics content
 - (1) 5% or less- 0% of Contractor payment
 - (2) Greater than 5% but less than 7.5% - 25% of Contractor payment
 - (3) Greater than 7.5% but less than 10% - 50% of Contractor payment
 - (4) Greater than 10%, equipment will be rejected and manufacturer shall reimburse District of all costs for providing and installing grit washing equipment.
 - b) Moisture content
 - (1) 10% or less – 0% of Contractor payment
 - (2) Greater than 10%, but less than 20% - 25% of Contractor payment
 - (3) Greater than 20%, but less than 30% - 50% of Contractor payment
 - (4) Greater than 30%, equipment will be rejected and manufacturer shall reimburse District of all costs for providing and installing grit washing equipment.
- 3) Construction Manager shall be present for test.
- c. Test Procedure
 - 1) As a requirement of this specification the manufacturer shall demonstrate that the grit washer(s) conform with the performance and operating criteria specified herein and the following tests shall be conducted at site on each operating grit washer unit:
 - a) Contractor shall provide clamp on type flow meter and shall be attached to grit delivery pipe from the grit pump and after calibration, flow readings shall be taken for a minimum three pumping cycles, or over one half hour of continuous run time, to demonstrate the grit classifier is operating at the specified flow.
 - b) The organic content and moisture tests shall take place over a two week period. District staff shall take three (3) random 2-cup samples taken any 3 days within a consecutive two week period for a total of 9 samples. Samples shall be taken immediately upon discharge from each classifier, sealed in a vapor tight container and sent out for testing the same day.
 - 2) The test results and observations shall be submitted for approval and acceptance by OWNER.

END OF SECTION

SECTION 11330 – FILTER SCREENS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide the screen equipment shown and specified, complete with automatic spiral screen, motor, drive, screw, control panels, piping, valves, controls, and accessories to install a screening facility to positively remove screenings from the influent wastewater, complete and operable, in accordance with the Contract Documents.
- B. All equipment and items shall be from manufacturers with at least 10 years of experience in the manufacture and assembly of similar products, with a record of successful installations. Such manufacturers shall maintain a well established, authorized, local service agency with sufficient spare parts and personnel to respond within 48 hours to any service calls.
- C. Description of System
 - 1. The screening equipment shall remove screenings from the influent wastewater flow. The screening equipment shall be installed upstream of the grit removal equipment as shown in the Contract Documents. Flow shall enter the screening tank and pass through the screening element which is a perforated basket that is installed as an integral part of the screenings tank. Captured screenings shall be removed from the screening basket by a brush attached to a rotating, inclined spiral screw.
 - 2. During the cleaning cycle the screw shall rotate, remove screenings from the screening element and transport them up the screw for dewatering, compaction and discharge to a discharge point as shown in the Contract Documents.
 - 3. Designs employing the use of endless moving media, cables, and hydraulic cylinders or raking mechanisms to remove debris from the channel will not be acceptable. Also, the screening process shall employ only a single motor driving a single screw that accomplishes screen cleaning, screenings transport, dewatering and compaction. Designs employing the use of multiple motors and/or screws will not be acceptable.
- D. Scope of Specifications: The equipment covered by this Specification is intended to call attention to certain features and requirements of the work, but does not purport to cover all details of the supply and construction of the Filter Screen system. Ancillary and accessory devices necessary for meeting the performance, operational, and reliability requirements specified herein shall be provided by the Filter Screen Supplier whether specified or not.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA

- C. ASME
- D. ANSI
- E. NFPA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings: Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, power drive assemblies, parts, devices, tanks, supports, panels, and other accessories forming a part of the equipment furnished as well as schematics, diagrams, and panel layouts, shall be submitted for review in accordance with Section 01300 – Submittals, Product Data and Submittals.
- C. O & M Manuals: Prior to start-up the Contractor shall furnish to the Owner complete operations and maintenance manuals in accordance with Section 01300 – Submittals Drawings, Product Data and Submittals and Section 01730 – Operations and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for the equipment shall be furnished as a part of the Work; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
- B. Warranty

1. Warranty: The manufacturer will warrant against any defects in material or workmanship to the Filter Screen system. This warranty will comply with the requirements of Section 01740 – Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730 – Operations and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 1. 1 person-days for installation assistance and inspection,
 2. 1 person-days for functional and performance testing
 3. 1 person-days for pre-startup training of OWNER's personnel.
- B. The Engineer shall require that the testing, startup, and training services above be furnished in a minimum of two separate trips.
- C. No additional compensation shall be provided for the services of the manufacturer's service representative.

PART 2 PRODUCTS

2.1 GENERAL – SC-EQP1 AND SC-EQP2

- A. General: Materials employed in the equipment shall be suitable for the intended application; materials not specifically called for 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.
- B. Wherever it is specified that a single manufacturer shall be responsible for the compatible and successful operation of the various components of any equipment unit, it shall be understood to mean that the Contractor shall furnish and install only such equipment as the designated manufacturer will certify is suitable for use with its equipment and with the further understanding that this in no way constitutes a waiver of any specified requirements.
- C. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.
- D. The Manufacturer shall provide all sizes and embedment details for all anchor bolts required to meet the seismic design requirements, and conform to all the requirements shown on Drawing S-1.

2.2 PERFORMANCE REQUIREMENTS

- A. Peak Design Flow: 3 mgd
- B. Minimum Design Flow: 0.25 mgd

- C. Maximum Clean Screen Headloss Through Screen At Peak Design Flow: maximum of 9 inches
- D. Spiral Screen Opening Size: ¼ inch
- E. Guaranteed Screenings Dry Solids Content: 40% (meeting the EPA Paint Filter Test specification for landfill disposal)
- F. Screening Element/Screenings Screw Inclination: 48 degrees

2.3 MATERIALS OF CONSTRUCTION

- A. General: Unless otherwise specified in these specifications, the entire equipment shall be manufactured from type 316 stainless steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the O&M manual.

1. The entire equipment shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with foreign contaminants.
2. The equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.

- B. Screening Element

1. The screening element shall be a semi-circular, perforated screen basket installed in the screenings tank as shown on the Contract Drawings.
2. The screening element shall be made of type 316 stainless steel.
3. Base plate: The basket shall have a base plate along the bottom to provide adequate support at the base of the unit and prevent bypass underneath the screen.
4. Channel bottom shall be sloped as required by screening manufacturer. CONTRACTOR shall coordinate with MANUFACTURER to determine channel bottom configuration prior to installation and construction of the channel.
5. Side seals: Neoprene side seals shall be securely attached to the sides of the upstream side of the screening basket with stainless steel retainers and hardware to prevent bypass between the screen and channel walls. Deflector plates shall be provided by the selected manufacturer if required to prevent bypass between the screen and channel walls.

6. The screening basket shall be removable without the need to remove the spiral.
7. Spray Wash Assembly
 - a. A spray wash assembly shall be installed near the top of the basket to provide additional cleaning of the basket.
 - b. Spray bar assembly shall be constructed of type 316 stainless steel.
 - c. Up to 16 US gpm of plant utility water at 60 psi shall be provided at a location recommended by the screen manufacturer.
 - d. The following equipment shall be supplied by the screen manufacturer to control spray wash water:
 - 1) One (1) $\frac{3}{4}$ inch diameter manual ball valve (bronze body)
 - 2) One (1) $\frac{3}{4}$ inch diameter ASCO brass body solenoid valve, which shall be explosion proof or intrinsically safe and shall comply with the hazard area classifications shown on the Contract Documents.

C. Spiral Screw Assembly

1. The spiral screw shall be designed to transport, dewater and compact the screened material. The spiral screw shall include the following areas: screening area, transport area, compaction area and discharge area.
2. The screw length, orientation and discharge height shall be as shown on the Contract Documents.
3. The spiral screw shall have a stub shaft attached to the gear motor. The design shall allow for the screw to be replaced as an individual item without the need to disconnect the drive system from the unit, or removing the shaft from the gearbox.
4. The spiral and shaft (where provided) shall be made of type 316 stainless steel.
5. A replaceable brush shall be mounted on the outside of the spiral in the screening zone to clean the surface of the screening basket. The brush shall be attached to the screw with type 316 stainless steel fasteners. Brushes fastened to the screw by clips which may pull loose or require welding or cutting to replace are not acceptable.
6. The brush shall be made of nylon bristles molded into a plastic core and shall be suitable for long-term immersion in raw wastewater. The brush shall be sectioned, for ease of replacement, with individual sections covering 180 degrees of the spiral, combining to form a continuous brush over the length of the basket. The sectioned brushes shall allow for individual replacement due to localized wear.
7. The screenings screw shall have a minimum solids capacity of 5 ft³/hr.

D. Drive Assembly

1. The drive assembly transmits power generated by the motor to the spiral screw and shall consist of a TEFC electric motor with a gear reducer and drive shaft.
2. Motor: The motor shall be induction type, TEFC, min. 1 hp, 1800 RPM, 460 volt, 3 phase, 60 hertz with a 1.15 service factor. The motor shall be rated at 40 degree C ambient with Class F insulation and shall have a Class B temperature rise at full

load and be direct coupled to the reducer. The motor shall comply with the requirements of Section 16222 – Motors, and the hazard area classifications shown on the Contract Documents.

3. The gear reducer shall be a helical gear type and be designed in accordance with the AGMA recommendations for Class II service based on the horsepower required to operate the screen.
4. The main drive shaft extends from the reducer into the end of the transport tube and shall be constructed of type 316 stainless steel. The free end of the drive shaft shall end in a mounting flange for connection to the spiral screw.

E. Conveyance Tube

1. The conveyance tube shall fully enclose the spiral screw and extend from the top of the screenings basket to the compaction area.
2. The conveyance tube shall be constructed of minimum thickness of 1/8 inch type 316 stainless steel.
3. Three replaceable wear bars shall be provided in the lower portion of the conveyance tube to support the spiral. All bolted connections between the wear bars and the tube shall be sealed with specially shaped plastic washers and all heads of the screws shall be external to the unit to allow for periodic tightening of adjustment of the bars. Wear bars shall be replaceable without requiring welding or replacement of the tube.
4. The wear bars shall be made of type 316 stainless steel.
5. A hinged support stand with base plate shall be mounted to the underside of the conveyance tube. The support stand shall be vertically adjustable and shall be made of type 316 stainless steel. The support stand shall be provided by the screen manufacturer and shall be designed per the screen manufacturer's recommendations to support all structural and process loads, and comply with all applicable seismic requirements.
6. A spray wash assembly shall be installed to rinse the solids as they move up the transport tube. The spray wash assembly shall include the following components:
 - a. Spray bar assembly constructed of type 316 stainless steel.
 - b. Up to 15 US gpm of plant utility water at 60 psi shall be provided at a location recommended by the screen manufacturer.
 - c. The following equipment shall be supplied by the screen manufacturer to control spray wash water:
 - 1) One (1) 3/4 inch diameter manual ball valve (bronze body)
 - 2) One (1) 3/4 inch diameter ASCO brass body solenoid valve, which shall be explosion proof or intrinsically safe and shall comply with the hazard area classifications shown on the Contract Documents.

F. Compaction Zone

1. A compaction zone shall be an integral part of the screenings screw conveyor and conveyance tube design. The compaction zone shall be designed to form a screenings plug of material.
2. The design shall allow for water released from the screened material to be returned back to the wastewater channel through holes that are machined into the screenings conveyance tube. The holes shall connect to a drainage pipe that discharges to the screenings channel downstream of the screening element. The drainage pipe shall be securely mounted to the screw conveyor and the drainage pipe discharge shall be securely mounted to the screenings channel, above the high water level in the screenings channel.
3. The compaction zone housing shall be furnished with a top-mounted latched and gasketed access cover to allow access to the screw conveyor should the compaction zone ever become plugged. The access door shall expose the entire length and width of the compaction and discharge areas and shall be constructed of type 316 stainless steel and mounted with type 316 stainless steel hinges. A safety micro switch shall be installed to prevent the screen from running while accessing the compaction zone and discharge sections.
4. A spray wash assembly shall be installed to rinse any residual solids from the drain area of the enclosure. The spray wash assembly shall include the following components:
 - a. Spray bar assembly constructed of type 316 stainless steel.
 - b. Up to 15 US gpm of plant utility water at 60 psi shall be provided at a location recommended by the screen manufacturer.
 - c. The following equipment shall be supplied by the screen manufacturer to control spray wash water:
 - 1) One (1) $\frac{3}{4}$ inch diameter manual ball valve (bronze body)
 - 2) One (1) $\frac{3}{4}$ inch diameter ASCO brass body solenoid valve, which shall be explosion proof or intrinsically safe and shall comply with the hazard area classifications shown on the Contract Documents.

G. Discharge Chute

1. A fully enclosed discharge chute shall be provided at the point of discharge to direct screenings into the receiving device as shown on the Contract Drawings.
2. The upper portion of the discharge chute shall be made of min 14 gauge thickness type 316 stainless steel. The upper portion of the discharge chute shall be of the dimensions and installation angle as shown on the Contract Drawings.
3. A flexible neoprene chute shall be securely attached to the upper portion of the discharge chute with removable stainless steel fasteners. The flexible neoprene chute shall allow for field adjustment and shall be of adequate length to attach to the screenings conveyor. The Contractor shall be responsible for coordination between the screen manufacturer and the conveyor manufacturer.

H. Manual Bar Rack

1. A manual bar rack shall be provided in the bypass channel as shown in the Contract Documents.

2. The bar rack shall have 1-inch clear openings and the bars shall be 1" deep by 1" wide and shall be constructed of type 316 stainless steel with 1/4 " continuous fillet welds at all joints. The maximum clean screen headloss through the bar screen at peak design flow shall be no larger than the headloss through the spiral screen. The screen shall be of the size shown on the Contract Drawings and shall be removable.
3. A hand rake of suitable length shall be provided. The rake teeth shall be designed to mesh with the bar spacing on the manual bar rack.

2.4 CONTROLS

A. General

1. The control package, complete with all components specified herein shall be provided by the screen manufacturer and shall provide for total automatic operation with protection against overload conditions.
 2. The intent is that the Contractor provides power and control wiring, as required, to the screen manufacturer supplied control panel, and from the control panel to the junction boxes mounted on the equipment.
 3. The screen manufacturer shall provide all control components, field wiring, conduits and supports, interconnection wiring of proper size, and all other electrical items required for connecting all screen manufacturer supplied equipment, motors, instruments, hand switches etc that are associated with the equipment and shall route this wiring to junction boxes mounted on the screening equipment. The junction boxes, and all associated mounting hardware shall also be supplied by the screen manufacturer.
 4. In order to minimize electrical and controls field coordination, the Contractor shall provide all control components, field wiring, conduits and supports, interconnection wiring of proper size, and all other electrical items required to connect from the screen manufacturer supplied control panel to the screen manufacturer supplied junction boxes on the screening equipment.
 5. All wiring, and electrical and controls equipment shall comply with the Hazard Area classifications shown in the Contract Documents.
- B. The screen manufacturer supplied control panel shall be delivered prewired to the site. The control panel shall be stanchion mounted to the platform as shown on the Contract Documents.
- C. The control panel shall be lockable and the screen manufacturer shall supply five (5) sets of keys.
- D. Controls: Controls shall be housed in enclosures with NEMA ratings which comply with the area designations of Section 16000 – Electrical – General Provisions.
- E. The power supply shall be 460 volts, 3 phases, 60 hertz.
- F. Control Panel

1. The main control panel shall be a totally enclosed, front access type. The panel shall be manufactured by a U.L. listed control panel facility and shall bear a U.L. label. Construction of the control panel enclosure shall be NEMA 4X, 316 stainless steel with indicating devices and switches mounted on the front door.
2. The control panel shall come with all power and control devices shown on the Contract Drawings, including, but not be limited to the following:
 - a. Dry contacts for connections the plant SCADA system:
 - 1) Remote indication of "Over Current" status
 - b. Switches and indicating lights shall be provided on the front of the control panel:
 - 1) One (1) control power ON-OFF selector switch
 - 2) One (1) HAND –OFF –AUTO selector switch for operation of the screen drive.
 - 3) One (1) HAND –OFF –AUTO selector switch for operation of the spray wash assemblies.
 - 4) One (1) FORWARD – OFF – REVERSE selector switch for manual operation of the screw. Spring return from REVERSE to OFF.
 - 5) One (1) green pilot light for "Screen Run" indication
 - 6) One (1) amber pilot light for "Over Current" indication.
 - 7) One (1) amber pilot light for "High Level Alarm".
 - 8) One (1) white pilot light for control power.
 - 9) One (1) momentary "reset" push-button for over current reset.
 - c. Other components:
 - 1) One (1) single channel electronic control timer to automatically initiate operation of the spiral screen. The time shall be capable of up to 30 events (on, off or momentary on).
 - 2) One (1) elapsed time meter.
 - 3) Control relays, wiring and circuitry required to implement the control logic.
 - 4) One (1) full voltage NEMA rated reversing starter. The magnetic starter shall be of the heater less design and provide phase loss protection, short circuit self-protection and thermal memory. The solid-state overload shall be self-powered.
 - 5) One (1) circuit breaker
 - 6) One (1) 120 VAC control power transformer
 - 7) One (1) current sensing relay. The current sensing relay shall continuously monitor the motor current to prevent damage due to a jam obstruction or unit malfunction. An over current condition that causes motor shutdown shall cause an alarm to sound. The alarm shall be manually reset prior to the unit returning to normal operation.
 - 8) A safety micro switch shall be installed in the screenings tank to prevent the screen from running while accessing the tank area.
 - 9) A safety micro switch shall be installed to prevent the screw from running while accessing the compaction zone and discharge sections.
3. Auxiliary (Local) Control Stations

- a. The spiral screw shall be provided with an auxiliary control station located as shown on the Contract Drawings to provide for maintenance flexibility and service.
- b. The auxiliary control station shall be provided an explosion proof or intrinsically safe enclosure constructed of type 316 stainless steel and shall comply with the hazard area classifications shown on the Contract Documents, and shall include the following:

- 1) One mushroom head "EMERGENCY STOP" push button.

G. Ultrasonic Level Sensors

1. One (1) ultrasonic level sensor shall be located upstream of the screening element in each screen channel to initiate the cleaning cycle. The ultrasonic level will also trigger a high level alarm based on an adjustable high level set point.
2. The Screening Equipment Supplier shall be responsible for providing and mounting of the ultrasonic level sensors and all wiring from the ultrasonic level sensors to a junction box. The junction box shall also be supplied by the Screening Equipment Manufacturer and shall be mounted near the top of screen tank, at a location that does not interfere with the adjacent support platform as shown on the Contract Drawings.
3. The Contractor shall provide all wiring from the junction box to the local control panel.
4. The ultrasonic level sensors shall comply with the requirements of Section 13400 – Instrumentation and Control System.

H. The Control Panel shall have the capability to communicate with the Plant SCADA system via a MODBUS TCP communication port. Any and all control and monitoring signals from the field to the Screen Control Panel shall be available to the Plant SCADA system via this communication port. The control panel shall have internal Programmable Logic Controller capable of communication to the Plant SCADA PLC.

2.5 SPARE PARTS

- A. The Contractor shall obtain from the manufacturer a list of suggested spare parts of all items of each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, bearings, etc.. Furnish spare parts suitably packaged and labeled in a box in the same manner as required for tools.
- B. The spare parts shall include, but not necessary be limited to:
 1. One (1) set of wear bars with attachment hardware
 2. Three (3) brushes for the spiral
 3. One (1) solenoid valve rebuild kit

2.6 PROTECTIVE COATING

- A. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.7 MANUFACTURERS

- A. MANUFACTURER's Experience: The contractor shall provide products which have at least 10 years in operation. No equipment shall be considered which has an operating history of less than 3 years. Manufacturer shall have a minimum of 50 units in operation in the U.S. for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The screen manufacturer shall be responsible for all equipment provided under this section.
- C. Manufacturers or Equal:
 - 1. Huber.
 - 2. Lakeside.
 - 3. Westech.
- D. Any use of substitute equipment shall not relieve the CONTRACTOR of providing a complete and operable system in complete conformance to the specifications, including all performance parameters and interfacing requirements.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. General: Equipment shall be installed in accordance with governing safety standards, manufacturers written recommendations, procedures submitted with the shop drawings, and as indicated on the drawings, unless otherwise approved by the Engineer.
- B. Lubricants: The Work shall include furnishing the necessary oil and grease for initial lubrication and testing of all equipment.

3.3 TESTING

- A. General
 - 1. Provide testing in accordance with Section 01650 Facility Start Up.
- B. Factory Testing
 - 1. Screening equipment shall be factory assembled and factory run tested prior to shipment. The main control panel shall also be factory tested.

2. Certified factory test reports shall be submitted.

C. Field Testing

1. Screening equipment shall be field tested to confirm verify proper alignment and operation without vibration, jamming, overheating or other defects and that all components perform their specified functions satisfactory.
2. Upon completion of installation, the equipment should be operated for a minimum of 8 hours to ensure that all clearances, vibrations, tracking and motor operating characteristics are within acceptable limits.
3. 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.

D. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01650 Facility Start Up.

END OF SECTION

SECTION 11403 – FFR MEDIA

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install PVC structured sheet media modules, protective surface grating, and filter media support system in accordance with the Contract Documents.
- B. System Definition
 - 1. Structured PVC Media Modules: Media modules are fabricated from PVC sheets and completely corrugated at an angle of 60 degrees from horizontal to form a cross-corrugated pattern between adjacent sheets. Sheets shall be alternated to create a cross-corrugated pattern from sheet to sheet. Modules will be 2 feet high, and 1- 2 feet wide and 4 - 8 feet long.
 - 2. Protective Surface Grating: Interlocking polypropylene panels, a minimum of height of 1-1/4 inches, shall be supplied to absorb hydraulic impact, provide operator access, provide a protective layer from foot traffic.
 - 3. Media Support System: Structural system designed and supplied by MANUFACTURER to support structure PVC media modules while maximizing ventilation and drainage. Support system shall be pre-engineered PVC/glass-reinforced ABS piers supporting pultruded fiberglass grating, or alternatively reinforced concrete piers and pre-cast, pre-stressed concrete lintels.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. ASIC
- C. PCI

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 Submittals.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data. O&M instructions shall include storage and installation procedures, operating instructions, and maintenance instructions.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal

tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

- E. Samples: Samples of the structured PVC media module, media support system, and protective surface grating shall be submitted. Samples shall be retained by OWNER and/or ENGINEER. Acceptable MANUFACTURERS named herein are not required to submit samples.
- F. Inspection, Startup, and Field Adjustment Certification: Provide certifications of compliance with the requirements herein.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. MANUFACTURER's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 0.5 person-days for functional and performance testing
3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

- A. The requirements of Section 11000 – Equipment General Provisions apply to this section.

2.2 PERFORMANCE REQUIREMENTS

- A. Quantity and Dimensions: CONTRACTOR is responsible for verifying final dimensions of the required FFR equipment in the field. The dimensions of the FFRs, as shown in the Contract Drawings, are shown in Table 1.

Table 1 - FFR Dimensions

Number of Fixed Film Reactors	2
Fixed Film Reactors Diameter (feet)	40
Fixed Film Reactors Depth (feet)	34
Approximate Volume of Media Required (ft ³)	85,500

- B. Tolerances:

1. Media support system shall be installed true level, $\pm 1/2$ inches in height.
2. Structured PVC media modules shall be constructed to ensure that solvent bond points are within 1/2 inch from the top and bottom of the modules on all sheets.
3. Structured PVC media modules tolerances for height, width and length shall be $\pm 1/2$ inches for each dimensions (tolerances may vary by sheet thickness).
4. A maximum of 2 inches is allowed during installation between the field-cut edges of the structure PVC media modules and the tank perimeter wall and the center column.
5. The top of the media support system and the top of the support ledge should be at the same elevation and within a maximum tolerance of $\pm 1/8$ inches in elevation.

- C. Media Support System

1. Existing W8 x 3/8" fiberglass cross beams that support the media shall be replaced. Replacement beams and anchorage to existing concrete knee walls or anchorage to existing structure shall be designed in accordance with Section 01612 – Seismic Design Criteria. The design shall be approved and stamped by a California Registered Engineer.
2. Media Support System shall be designed and pre-engineered to support the design load (40 lbs/ft² per feet of media) of structured PVC media modules. The media support system must allow for field adjustments to meet height tolerances, and be readily adjustable to allow for variations in floor slope to ensure vertical alignment of piers. New concrete piers, if used, must provide adequate re-bar reinforcement and pre-cast, pre-stressed concrete lintels must be engineered to

meet the load requirements and shall be installed with lintels at a maximum of 2 feet center-to-center spacing. Concrete masonry units such as cinder blocks, underdrain tiles or other such inadequate structural members will not be acceptable. Similarly, grouting to achieve leveling requirements will not be acceptable as structural load bearing material, except as necessary to secure lintels to piers.

3. Media support system shall be designed and engineered to maximize ventilation and drainage requirements, while ensuring sufficient contact with structured PVC media modules such as to prevent media from wrapping around supports. Pre-engineered systems shall incorporate nominal 12-in. (350 mm) wide pultruded fiberglass grating of adequate strength to meet the design load, while not allowing excessive deflections.
4. Media support system shall be installed within an existing structure and shall be designed to work with the existing concrete support beams. The media supports shall be designed to support the existing air header and duct system.

D. Structured PVC Media Modules

1. Each structured PVC media module shall be 100% cross-flow and completely corrugated at an angle of 60 degrees from the horizontal to form a cross-corrugated pattern between adjacent sheets, providing a continuous and horizontal redistribution of air and wastewater. The module shall ensure adequate contact and diffusion between liquid, air and. Random, vertical or horizontal media are not acceptable.
2. The flute height for each corrugation in the Structured PVC Media Module shall be 1.0 - 1.20 inches. There shall be a minimum of 20 sheets per 24-inch wide module.
3. Each Structured PVC Media Module must provide a minimum surface area of 31 ft²/ft³ with a minimum of 95% void-to-volume ratio.
4. Each module shall have a minimum bearing capacity of 400 lbs/ft². Modules in the top layer shall have a minimum bearing capacity of 1000 lbs/ft². In addition, media modules shall be capable of withstanding a minimum loading of 40 lbs/ft² per foot of media height above the module as placed in the filter. Media modules in the bottom layer shall have the designed load bearing capacity as estimated by the loading of lbs/ft² per foot of media height or 1000 lbs/ft², whichever is greater, when placed on media supports.
5. The maximum allowable deflection shall be 1% at a test temperature of 75° F.
6. The finished modules shall be suitable for normal wastewater temperatures between 50° F and 75° F.
7. The media shall be designed to accommodate the existing air header and duct system while maintaining the structural integrity and stability of the installed media modules.

E. Protective Surface Grating

1. Protective Surface Grating shall be a minimum 1-1/4 inch in height for additional top layer UV protection. Additionally, no greater than a 2 inch in diameter opening will be allowed for protection from hydraulic impact. Protective grating must have a non-skid surface. Protective Surface Grating must not adversely impact or damage media modules.

2.3 MATERIALS OF CONSTRUCTION

A. Media Support System

1. The media support system stanchion, if used, shall be constructed of rigid PVC or rigid FRP.
2. MANUFACTURER is responsible for ensuring adequate structural integrity consistent with the requirements specified.
3. Alternatively, concrete piers and concrete lintels of adequate structural integrity may be substituted for MANUFACTURER's pre-engineered system. If concrete piers and lintels are substituted, Fixed Film Reactor Media System MANUFACTURER is responsible for ensuring adequate structural integrity of all new support elements and their connection with existing consistent with the requirements specified.

B. Structured PVC Media Modules

1. The media shall be fabricated from rigid PVC sheets completely corrugated at an angle of 60 degrees from horizontal, and arranged to form a cross-corrugated pattern with adjacent sheets to permit adequate contact between air, wastewater and biomass. The PVC roll stock sheets shall be of uniform thickness with no section less than ± 0.002 inch manufacturing tolerance. The media modules shall be specifically designed to use in the biological oxidation of municipal wastewater.
2. The material of construction shall be flame resistant, self-extinguishing, rigid corrugated PVC sheets that are conducive to biomass and UV protected. The media modules shall be resistant to rot, fungi, bacteria and inorganic/organic acids and alkalies as commonly found in municipal wastewater.
3. PVC sheets shall be of uniform thickness, enforced edges are allowed, and free from holes, air bubbles, foreign matter, undispersed raw material or other manufacturing defects that may adversely affect their performance.
4. PVC sheets shall be prime, rigid PVD conforming to commercial standards ASTM D1784: 12344B to 12454B with the physical properties shown below:

Property	Test Method	Unit	Typical Value - PVC
Specific Gravity, maximum	D792	g/cm ³	1.50
Tensile Strength, minimum	D638/D882	psi	6,000
Flexural Modulus, minimum	D790	psi	425,000

Flexural Strength, minimum	D790	psi	11,000
Impact Strength, minimum	D5420	in. lbs. / mil	0.8
Impact resistance, notched Izod	D256	in. lbs. / mil	N/A
Stiffness Flexure, minimum	D747	psi	525,000
Heat Deflection, minimum	D648	°F (264 psi)	160
Flammability	D635	self-extinguishing less than 5 seconds	

C. Protective Surface Grating

1. The protective surface grating when installed as per MANUFACTURER's recommendations shall provide a continuous protective surface for the Structured PVC Media Modules, minimizing hydraulic impact on the media, providing additional UV protection, and allowing operator access to all areas of the tower. Such grating shall comprise of openings no greater than 2 inches in diameter, molded together to provide a strong, lightweight panel.
2. Material of protective surface grating shall be rigid polypropylene specifically UV stabilized for inhibiting UV degradation under extended exposure to the sun. The material shall be inert and resistant to naturally occurring wastewater constituents.
3. Protecting surface grating shall be installed side-by-side and placed on top of the media modules as shown on the MANUFACTURER'S installation drawings. Each panel shall be snapped together with the adjacent panel with locks provided at the edges of each panel. The grating panels shall be placed on top of the media such that the grating is in contact with the media.
4. The grating shall be designed to prevent damage to the media, and allow for ease of placement and removal. The material design shall be such that hold down ties, clips or fasteners are not required.

2.4 FABRICATION

A. Media Support System

1. The media support system shall be comprised of pultruded fiberglass grating.
2. Pultruded fiberglass grating shall be placed across the tops of existing concrete beams, or across tops of replacement FRP cross beams.

B. Structured PVC Media Modules:

1. All PVD sheets shall be thermoformed into corrugated sheets. When fabricated into modules, the sheets shall be alternated to create a cross-corrugated pattern.
2. The self-supporting structured PVC media modules assembled from the thermoformed sheets shall be bonded together to create a cross-corrugated pattern between the adjacent sheets. Adhesive glues are not acceptable.

C. Protective Surface Grating

1. The protective surface grating shall be molded as individual units complete with self-interlocking connections.

2.5 PROTECTIVE COATING

- A. There shall be no coatings applied on the structure PVC media modules. The media support system and protective surface grating shall not be coated. The protective surface grating shall have a clean surface free from imperfections, providing a walkable surface for operators.

2.6 SPARE PARTS

- A. None required.

2.7 MANUFACTURERS

A. MANUFACTURER's Experience:

1. The structured PVC media MANUFACTURER shall have a minimum of 10 similarly-sized installations in wastewater treatment applications in the U.S., and at least 5 years of continuous experience in manufacture and supply of structure PVC media modules.
2. The structured PVC media modules shall be a standard product of the MANUFACTURER. MANUFACTURER shall certify that they have existing installations of structure PVC media modules.

- B. Unit Responsibility: The CONTRACTOR shall assign to a single Supplier full responsibility for the furnishing and functional operation of the complete FFR media system. The designated single Supplier, however, need not manufacture more than one part of the unit, but shall coordinate the design, assembly, testing, and erection of the unit as specified herein.

C. MANUFACTURERS, or equal:

1. Brentwood Industries
2. Raschig USA, Inc.
3. ENEXIO, formerly GEA

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

A. Delivery

1. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

2. Structure PVC media modules shall be shipped and delivered to project site on pallets for ease of handling and to prevent damage.

B. Storage

1. All material and equipment shall be shipped, stored, handled, and installed in such a manner as to not degrade quality or serviceability.
2. Structured PVC Media Modules shall not be stacked more than 8 feet high (one over the other). All modules shall be stored on the shipping pallets.
3. All modules shall be stacked such that the PVC sheet planes are in a vertical position (similar to the manner of their placement inside the tower).
4. A light colored tarp shall cover all modules required to be stored in the open beyond 60 days. Clear or black tarps are not acceptable.
5. Deformations due to Memory effects of thermofolded PVC Modules shall be avoided: Covers cannot be wrapped tightly around the media. There should be at least a 6 inch air gap between the cover and top of media. The ends of the cover should be securely anchored on all sides with at least a 12 inch air gap at the bottom. These covers should provide shading while allowing air to pass through to prevent heat from building up.
6. Modules should be checked at least once a week. Covers can become loose over time due to wind or rain and must be re-secured. A check of the stored area should be done to make any minor repairs to the cover or to restack any modules that may have fallen.
7. Structured PVC Media Modules exposed to extended non-operational periods in the tower shall be adequately protected to prevent damage by temperature and weather conditions.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

- A. General: Furnish labor, piping, equipment and material for conducting the tests.
- B. Factory Testing shall conform to the following criteria:
 1. The test sample shall consist of four full-size media modules stacked two modules high with two modules in each layer. The arrangement of the stack shall simulate the geometry as placed in the filter towers. The top modules shall be perpendicular to the bottom modules, and the PVC sheet planes shall be in a vertical position.
 2. Modules intended for the base layer shall be tested on a simulation of the Media Support System. Modules intended for all other layers shall be tested on a flat base.

3. Test loads shall be the design load of the media as specified. The test load shall be at a temperature of 75°F ±2°F.
4. A preload equal to 10% of the design load shall be applied to act as a seating load. This seating load shall be retained for a 1-hour period.
5. After 1 hour, the deflection shall be noted and considered zero and the load increased in 10 percent increments of the design load. Each loading shall be held for 5 minutes and the deflection recorded at the end of the 5-minute period. Incremental loading shall continue until failure.
6. Maximum allowable deflection at the test load shall be 1%. Deflection is defined as the vertical deflection expressed as percent of the vertical distance between the top and bottom faces of the media stack under the pre-load conditions.
7. The Engineer shall have the opportunity to witness the media testing or the test results meeting the specified load criteria and maximum allowable deflection shall be certified by a P.E. and submitted to the Engineer for approval prior to the installation of the media.
8. All tested media modules shall come from the media production run that is specifically manufactured for the current project. Media packs from other projects shall not be accepted. Test data from previous projects are required before bidding and are not acceptable after bidding.
9. If any of the modules tested in any strength gradation exhibit a compressive deflection greater than 1%, additional testing will be required of eight additional modules to determine the structural suitability of the media. If the additional testing indicates the media does not meet the specified strength, then the media manufacturer shall replace all media of that strength gradation with new media meeting the specifications and passing the structural testing.
10. The Engineer shall have the right to send packs shipped to the jobsite to a designated lab for further testing if in his opinion the packs do not appear to have the strength specified. All expenses shall be at the cost of the media manufacturer.

C. Performance Testing

1. Performance testing of the full-scale equipment shall be required in accordance with Section 01650 Facility Start Up.

END OF SECTION

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SECTION 11606 – DIGESTER GAS HANDLING EQUIPMENT

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. This section includes the gas handling equipment for the anaerobic sludge digesters and all appurtenant work, complete and operable.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities

- A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11000 Equipment General and Section 15200 Valves, General apply to the work of this Section.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished in this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 - Submittals.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions

5. MANUFACTURER's printed installation instructions
6. Suggested list of spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. MANUFACTURER's Representative.** In accordance with the requirements of Section 01730, Operation and Maintenance Data, a MANUFACTURER's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 0.25 person-days for installation assistance, inspection, and for functional and performance testing
2. 0.25 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 LOW PRESSURE MANUAL DRIP TRAP

- A.** Low pressure manual drip traps shall be installed on gas handling equipment as shown on the Contract Documents to prevent the accumulation of water in the digester gas system.
- B.** Low pressure manual drip traps shall have 1 inch size NPT inlet and outlet connections. Drip trap shall be the rotating disc type. Gas escaping to atmosphere is not possible regardless of the disc position. An air inlet port shall be provided to permit free flow of condensate from reservoir when draining. All ports shall be "O" ring sealed. Storage capacity shall be 2.5 quarts. Construction shall be low copper cast aluminum body, cover plate, disc, and handle. Cover plate and disc shall be anodized. Internal working parts and fasteners shall be stainless steel. "O" rings shall be neoprene. Maximum

2.2 PROTECTIVE COATINGS

- A.** Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.3 MANUFACTURERS

A. Manufacturer's Experience

1. The equipment shall be supplied by a firm which has been regularly engaged in the design, fabrication, assembly, testing, start-up and service of digester gas handling equipment for a period of not less than five (5) years prior to the bid date of this contract.

B. Manufacturers or Equal:

1. Varec Biogas
2. Groth Corporation

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation and lubrication of the equipment shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

- A. Testing shall be in accordance with 01650, Facility Startup.

END OF SECTION

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SECTION 11690 – FUEL STORAGE TANK

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. General: Provide a packaged design diesel fuel oil storage tank for supply of fuel to an engine generator set. Fuel oil storage tank shall be complete in all respects in order to provide the engine with a reliable source of fuel. This Section includes providing and installing one (1) 2,000 gallon, above ground fuel storage tank system, including secondary containment, piping transition connections, fill ports with overfill prevention valves, spill containment basins, connectors, valves, tank appurtenances, tank hold down anchorage, leak detection.
- B. Provide complete working installations with all equipment for the proper operating condition. Documents do not necessarily show or list every item to be provided. When an item is not shown or not listed, and is clearly necessary for proper operation of equipment, provide an item which will allow the system to function properly at no increase in cost to the District.
- C. This project provides for the storage and use of combustible fuels, and Contractor shall take all necessary precaution for safety of handling and installing this Project. Contractor warrants that he/she is experienced on similar installations and operations.

1.2 STANDARDS

- A. NFPA 30, 99 and 329
- B. UL 58, 142, 971, 1316, 1746 and 2085
- C. OSHA, Construction, 29 CFR 1926.652
- D. California Electric Code 2010 edition
- E. California Fire Code 2010 edition
- F. National Electric Code
- G. California Building Code 2010 edition
- H. State of California Water Resources Control Board, AST Regulations, Health and Safety Code
- I. Petroleum Equipment Institute (PEI) RP100-2000
- J. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.
 - 1. The system shall be for use with fuel oil as described by NFPA321, "Basic Classification of Flammable and Combustible Liquids". As defined by this

standard, the fuel supply system shall be for use with "combustible liquids", those having a flash point at or above 100°F and further defined as class II or class III liquids. In no case shall a liquid defined as "flammable", or as "class I" or as having a flash point less than 100°F be used. In every case, the system shall not be used or applied at a temperature in excess of the flash point of the contents. Electrical equipment used in the system shall be in accordance with NFPA30, section 5-7, wherein it states "For areas where class II or class III liquids only are stored or handled at a temperature below their flash points, the electrical equipment may be installed in accordance with provisions of NFPA70, National Electric Code, for ordinary locations..."

2. The system shall be designed and installed in accordance with applicable sections of NFPA30, NFPA31, NFPA37, UL80 and UL142. The tank shall bear the label of Underwriters Laboratories standard 142 and UL508.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 – Submittals, CONTRACTOR shall submit the following:
 1. Complete structural calculations showing the governing stresses in all members and connections, and detailed shop drawings. Preliminary drawings shall be stamped by cover MANUFACTURER's PE. Final Drawings and calculations shall bear the stamp of California PE.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 1. MANUFACTURER's Certificate of Proper Installation
 2. Functional Test Certification
 3. Factory performance test reports
 4. Special shipping, storage and protection, and handling instructions
 5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01740 - Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative.** In accordance with the requirements of Section 01730 - Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 1 person-days for functional and performance testing
3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 ABOVE GROUND FUEL TANK AND APPURTENANCES:

- A.** 2,000 gallon UL 2085 listed above ground cylinder tank with standard fitting.
- B.** All welded steel atmospheric tank of rectangular construction built in accordance with codes and standards noted above for indoor use with fuel oil
- C.** Pipe thread connections shall be provided for:
1. Fuel oil supply, 0.75 inch
 2. Return oil supply, 1.0 inch
 3. Vent, 2.0 inch
 4. Emergency vent, 4.0 inch
 5. Drain, 0.75 inch, with fire rated drain valve
 6. An inspection port in the top shall be provided
 7. Vent sizes shall be as required by local codes and by UL 142 ,NFPA 31 and NFPA37 specification

- D. The tank shall be equipped with a welded steel channel base suitable for bolt attachment to a concrete pad
- E. The tank shall have interior corrosion protection.
- F. The exterior of the day tank shall receive a heavy duty industrial anti-corrosion coating and be finish painted
- G. The tank shall be steel double-wall construction bearing the UL 142 label and having a containment rating of 150% of the primary day tank. The containment shall be equipped with a leak detector that shall activate the "rupture" alarm described below. A drain with fire rated ball valve is to be supplied. The containment shall be equipped with a separate e-vent as required by UL 142.
- H. Provide a manual hand pump: Provide a manual hand pump integral to the storage tank for priming applications. The hand pump shall include manual bypass valves, check valve and be rated for 20-gallons per 100 strokes.

2.2 STEEL PIPE

- A. All above ground piping shall be black carbon steel, seamless or electric resistance welded, ASTM A53, Grade B, Schedule 40. Fittings for 2 inch and smaller pipe diameters shall be welded 3000 pound, malleable black iron. Where welding is not possible, threaded pipe will be allowed. The threaded fittings shall be 150 pound, malleable iron, black ASTM A197 or ASTM A47, dimensions conforming to ANSI B16.3; unions shall be 300 pound malleable iron, black ASTM A197 or ASTM A47, dimensions conforming to ANSI B16.3, brass to iron seat.

2.3 ALTERNATIVE EQUIPMENT:

- A. Should the Contractor choose to use approved equal equipment, a full equipment list together with shop drawings, and connection and installation details with equipment labeled on the drawing shall be provided at the time of bid, in order for the District to evaluate the proper equivalent of the alternative equipment. All alternative equipment shall be new, delivered from the manufacturer, and in working order.

2.4 MANUFACTURERS

- A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized diesel fuel oil storage tanks for a minimum of 5 years. The MANUFACTURER shall have furnished at least 50 diesel fuel oil storage tank of the type and size specified herein which have been in successful operation for at least 3 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The fuel storage tank manufacturer shall be responsible for all equipment provided under this section.

- C. Manufacturers or Equal:
 - 1. Convault
 - 2. Containment Solutions

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: The storage tank shall be installed as shown on the Contract Documents, on a housekeeping pad. Anchor tank to the pad.

3.2 TANK TESTING

- A. The day tank shall be supplied with manufacturers test certificates as below
 - 1. Tank test: pressure test, leak proof test and structural integrity/appearance test. The primary steel tank shall be pressure tested at 5 psig for 24 to 48 hours
 - 2. Level controller: operational test with liquid of level sensors, level indicator, level control, alarms, backup devices
 - 3. Pump: vacuum test, flow test, pressure test, leak proof test, ampere/voltage test, load test, overload test.

3.3 SIGNS, LABELS, AND IDENTIFICATION

- A. Contractor shall install and place all required signing on the tank, in accordance with the manufacturer's recommendations and regulatory requirements. Provide the list of signing labels and identification to the District or the District's representative prior to purchase, fabrication or installation.

END OF SECTION

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SECTION 11800 – DISK FILTER SYSTEM

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install a cloth media disk filter system with an automatic backwash cleaning and pumping system, complete in place as described herein, including all appurtenant equipment in accordance with the requirements of the Contract Documents.
- B. Function: The cloth media filter system shall perform removal of suspended particles from secondary effluent. The system will also produce a waste backwash flow which will be returned to the headworks.
- C. Unit Responsibility: All equipment specified in this Section shall be provided by a single manufacturer, who is hereinafter referred to as Supplier. The cloth media disk filter system package shall be the end product of one responsible system Supplier. The Supplier is responsible to the Owner for performance of all equipment systems indicated. As such, the Supplier shall provide third-party validation testing, start-up and training as described in this Section. The filter system will be installed in pre-cast concrete basins and connected to an electrical power supply and an automatic process control system.
- D. Multiple Units: Where two or more units of the same class of material or equipment are required, products of a single manufacturer shall be provided.
- E. Regulatory Agency Approval: The cloth media disk filter system shall have approval from the California Division of Drinking Water (DDW), formerly Department of Health Services (DHS), for the treatment of wastewater to tertiary recycled water standards for unrestricted use as defined in Title 22 of the California Code of Regulations.
- F. Number of Units: The Supplier shall provide two (2) filter units.
- G. Layout is based on the A-listed MANUFACTURER listed below in section 2.8, C. The arrangement of piping and equipment and foundations indicated on the Drawings may be modified as necessary for the specific model of filter provided. The cost of all modifications, including design services and DISTRICT and ENGINEER time for review and approval, shall be the responsibility of the CONTRACTOR at no increase in cost to the DISTRICT. The ENGINEER shall review the proposed modification to the original design and shall be the sole judge as to type, function, and quality of the modification.
- H. Scope of Specifications: The equipment covered by this Specification is intended to call attention to certain features and requirements of the work, but does not purport to cover all details of the supply and construction of the filter system. Ancillary and accessory devices necessary for meeting the performance, operational, and reliability requirements specified herein shall be provided by the Supplier whether specified or not.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

1. California Code of Regulations: Title 22, Division 4 and Related Sections

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings in accordance with the requirements of Section 01300 – Submittals. In addition to those requirements, the following specific information shall be provided according to the schedule given in the General Requirements. The content and format of the information shall conform to the General Requirements.
1. Complete descriptive information for all equipment, material (include ASTM UL/CSA, IEC designations, etc.), and devices being supplied. Include materials, sizes, and weights for all major components.
 2. Catalog cuts and data sheets for all manufactured items, including but not limited to pumps, motors, media handling equipment and control system components. Data sheets shall be highlighted as required to show actual items, sizes, dimensions, horse-powers, model numbers, styles, materials, included options, and specifications of proposed items to be provided. Submittal shall demonstrate that all similar components are the product of a single manufacturer.
 3. Process control descriptions, covering all modes of operation, startup, and shutdown, and sufficiently detailed to fully program the control system and provide fully automated operation of the process.
 4. Control diagrams, installation details, and layouts for all control panels being provided.
 5. Detailed specifications of proposed shop-applied painting and corrosion protection systems for equipment, components, appurtenances, and accessories. Submittal shall indicate proposed surface preparation method, type of prime coat, type of finish coat, number of coats, dry film thicknesses, and detailed manufacturer catalog cuts for each coating.
 6. Contact and pricing information for Suppliers of the filter media to be provided. Submit name, address, telephone number, and contact person for the primary media Supplier.
 7. Title 22 approval letter from DDW for disk filters for each type of media supplied.
- B. Installation Instructions: The Supplier shall submit installation instructions in accordance with the requirements of Section 01300 – Submittals.
1. Requirements for storage and protection of all delivered equipment and materials prior to installation.

2. Installation drawings and instructions for equipment installation.
 3. List of maintenance materials required for the equipment prior to and during startup, and list of maintenance materials furnished with the equipment. Submit requirements for routine maintenance prior to startup.
- C. Owner's Manuals: The Contractor shall submit Owner's Manuals in accordance with the requirements of Section 01730, Operation and Maintenance Data.
1. Provide a detailed Owner's Manual for the cloth media filter system including, but not limited to:
 - a. Detailed step-by-step instructions for all normal and abnormal operating procedures required to operate the equipment, including: process startup; process shutdown; process preparation for long-term shutdowns and service outages; observation and adjustment under normal operation; automatic operation; manual operation; inspection and assessment of filter media condition; regular preventative maintenance; major maintenance procedures; problem diagnostics and troubleshooting; tuning and optimization; and equipment removal and replacement procedures.
 - b. Detailed Owner's Manual for each manufactured equipment item in the filter system, including but not limited to pumps, motors, and filter disc equipment.
 - c. Control system configuration and programming documentation.
 - d. Operating parameters for optimal operation. Information shall include, but not be limited to backwash rate.
 2. Update Owner's Manuals as required following successful performance testing and facility startup.
- D. Startup and Training Plans: The Supplier shall submit startup and training plans in accordance with the requirements of Section 01730, Operation and Maintenance Data.
1. Detailed plan for testing during startup.
 2. Training plan.
- E. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- 1.4 QUALITY ASSURANCE
- A. The Supplier shall guarantee the filter system equipment and performance as required in the General requirements.
 - B. Certification Requirements: the disk filter system shall be UL, or equivalent, labeled and listed.
 - C. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

D. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Inspection, Startup, and Field Adjustment Certification: An authorized service representative of the Supplier shall certify in writing that the equipment and controls have been properly installed, lubricated, adjusted, and readied for operation. The representative shall have at least 2 years of experience in training and operation of the disk filter system.
- B. Manufacturer's Representative. In accordance with Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 1. 2 person-days for installation assistance and inspection,
 2. 5 person-days for functional and performance testing
 3. 2 person-days for pre-startup training of OWNER's personnel.

1.6 LAYOUT, ACCESS AND INTERFACE REQUIREMENTS

- A. Facility Layout: The two filter units shall be constructed in separate pre-cast concrete basins. Each unit shall have a separate effluent channel constructed as part of the concrete basin and discharge through a single effluent pipe connection. The two filters will be arranged for series or parallel operation using a set of butterfly valves on the influent and effluent pipes. Each filter unit will be arranged so that a unit can be isolated and drained for service while the other unit is operating. The Contractor shall be responsible for providing the pre-cast concrete basins and shall coordinate the dimensions and connection requirements with the filter manufacturer.
- B. Access Requirements: The filter system shall permit easy access to all controls and operators by operations personnel, and easy access to equipment units for

maintenance. Access shall be provided as described in the Contract Drawings. The access requirements shown on the drawings shall be considered minimum requirements that do not override any applicable laws, codes, and standards which are more stringent than these requirements.

C. Interfaces

1. The filter system will receive secondary effluent through a single pipe located aboveground.
2. Each filter unit will discharge to a separate effluent channel integrated into the concrete basin, which will discharge to a separate effluent pipe for conveyance of filter effluent to a downstream common pipe and disinfection process.
3. The two filters will be arranged for series or parallel operation using a set of butterfly valves on the influent and effluent pipes. Butterfly valves shall be provided by the Contractor.
 - a. In series operation, secondary effluent will pass through a 10 micron media filter prior to a 5 micron media filter.
 - b. In parallel operation, flow will be split evenly between one 10 micron media filter and one 5 micron media filter.
4. Each filter unit will include drainage outlets for fully draining all liquid from the basins for maintenance purposes.
5. The filter backwash system will pump backwash water to the headworks return box.
6. Chemical Injection:
 - a. Coagulant and Flocculant Addition: In the future, the DISTRICT may want to add coagulant or flocculant to improve filter effluent quality. Coagulant and flocculant chemicals could be added immediately upstream of the filter system. The type and dose of chemicals to be added to the influent water of the filter system, downstream of the flocculating clarified system, will be determined based on the objective of reforming flocs that can be more easily removed through the filters. Piping and connections for the injection of these chemicals shall be provided separately, and by others, from the filter system.
 - b. The Supplier shall assume that the filter package materials will need to accommodate, at a minimum, the following liquid coagulants and flocculants: alum, polyaluminum chloride, anionic and cationic polymers (flocculants).
 - c. The filters shall also be capable of accommodate an influent chlorine concentration of up to 20 mg/L.

PART 2 PRODUCTS

2.1 GENERAL – FIL1-EQP1 AND FIL2-EQP1

- A. Filter System: The filter system shall be an automatic backwash cloth-media disk filter utilizing microfiber pile fabric.
- B. Pilot Testing: The filter system provided shall have been pilot tested for at least one week at the WWTP. The cloth filter equipment manufacturers named herein have previously completed pilot testing at the District's wastewater treatment plant. If proposed by the Contractor, any manufacturer not named shall complete pilot testing. All costs for pilot testing shall be borne by the Contractor. The District will not reimburse the Contractor for any costs related to pilot testing.
- C. Scope of Work: The Supplier's scope of work includes, but is not limited to, sizing of all process components, layout of all systems, development of detailed control descriptions, and supply of major equipment and materials. The Supplier shall be responsible for coordinating with the Contractor for the structural installation of concrete basins; mechanical installation of interconnecting piping and valves; electrical installation of interconnecting wiring, power supplies, control circuitry, and MCC components; and I&C design of instrumentation and control systems.
- D. Scope of Supply: A partial summary of the Supplier's scope of supply is provided below as a guide, but does not necessarily cover every item to be provided. The Supplier shall conform to all requirements of these Specifications and shall provide a complete scope of supply with the Bid as required in the General Requirements. For those items not included in Supplier's scope of supply, the Supplier shall provide sufficient detailed information during the Bid for the Contractor to perform coordinated selection and design of those items.
 - 1. Center tube
 - 2. Filter discs and associated filter media
 - 3. Drive mechanism and motor
 - 4. Support frame and cover, if required
 - 5. Backwash pumping system including automatic valves
 - 6. Major equipment anchorage systems including anchor bolts for all equipment
 - 7. Custom fabricated components
 - 8. PLC and HMI control system programming
 - 9. Local control panels
 - 10. Special instruments
 - 11. Spare parts
- E. Service and Environment Conditions

1. Service Conditions: The equipment will be used in an industrial environment and must be designed and constructed to provide efficient performance, serviceability, long life, and ease of maintenance and operation.
2. Environment Conditions: The Work of this Section shall be suitable for long term operation under the following conditions:

Duty	Continuous, with periodic short and long term process shutdowns
Ambient environment	Outdoors
Ambient Temperature	35 – 100 degree F
Ambient Relative Humidity	5 – 95 percent
Project Site Elevation	Sea level
Filter Influent Characteristics	The influent water to be treated by the filter process is secondary-treated wastewater from a trickling filter process. Filter influent temperature is typically between 65 – 85 degrees F. The filter influent flow specific gravity is 1.0.

2.2 PERFORMANCE REQUIREMENTS

- A. Design Capacity of Each Unit: Flow rates for parallel and series operation:

Condition	Flow per Filter (mgd)	
	Series Operation	Parallel Operation
Minimum	0.25	0.25
Design Maximum	3	3
Hydraulic Maximum	4.5	4.5
Average	1.3	1.3

- B. Performance Guarantee: The filter system shall consistently meet the following performance criteria based on influent water with a maximum 24-hour average of 50 mg/L TSS at average daily flow:
1. Effluent TSS shall not exceed any of the following, as continuously measured and recorded by a turbidimeter (of the type specified in Section 13400 – Instrumentation and Control Systems) that has been properly calibrated per manufacturer's recommendations and Standard Methods calibration procedures:
 - a. 20 mg/L Monthly Average
 - b. 30 mg/L Weekly Average

2. The loading rate shall not exceed 7.26 gpm/sq ft at the maximum hydraulic flowrate in parallel operation with all units in service.
3. The filter shall automatically adjust to changing influent flows and influent water quality while continuing to meet effluent quality requirements specified herein, without the intervention of an operator.
4. At the design maximum loading rate, the backwashing rate shall not exceed the following as a percentage of influent flow:
 - a. 10 micron media: 6%
 - b. 5 micron media: 13%

2.3 MATERIALS OF CONSTRUCTION

A. General

1. Miscellaneous hardware, including nuts, bolts, washers, and fastener clips, shall be Type 316 stainless steel.
2. No dissimilar metals or connectors shall be in direct contact unless properly electrically insulated.
3. If the wet weight of the filter disk segment is greater than 50 pounds, lifting lugs and a lifting mechanism shall be provided.
4. Anchor bolts shall be provided for all equipment and shall be Type 316 stainless steel, at least ½ inch in diameter or as required by the manufacturer.
5. All major mechanical components and equipment provided under this Section, both field and panel mounted, shall be provided with permanently mounted name tags. Panel mounted tags shall be plastic; field mounted tags shall be stainless steel, stamped with inscriptions as shown or as provided by the Engineer. Panel mounted nameplates shall be engraved, rigid, laminated plastic type attached to the panel with stainless steel panhead screws. Unless otherwise noted, color shall be black with white letters. Letter height shall be ½ inch for all nameplates. Field mounted tags shall be 16-gauge, 316L stainless steel with ½-inch high characters.

B. Center Tube

1. Each center tube shall be a water-tight, one-piece, structural-welded, and type 316 stainless steel fabrication (minimum 1/8" thick), open at one end.
2. Each center tube shall have openings to the filter discs.

C. Disc Assembly

1. Each filter unit shall be composed of removable discs. Each disc shall consist of disc segments that can be easily mounted or dismounted as required. The segments of one disc will be bolted to each other and to the center drum.
 - a. Each cloth disc assembly shall be comprised of six (6) individual segments, each consisting of a cloth media sock supported by an injection molded

polypropylene co-polymer frame with corrosion resistant assembly hardware.

2. Or, the filter disk frame may be constructed from Type 316 stainless steel as an integral unit completely welded and incorporated into the disk frame.
3. The replacement of the filter media must be possible from outside of the filter tank.

D. Filter Media: The filter media shall meet the following requirements:

1. Media shall be of microfiber pile construction and approved by the California Division of Drinking Water
2. Manufacturer shall provide two complete sets of filter media:
 - a. One set shall have a nominal filtration rating of 10 microns
 - b. One set shall have a nominal filtration rating of 5 microns

E. Drive System

1. Each unit shall include a drive mechanism to rotate the center tube/disc assembly during the backwash cycles.
2. The drive mechanism shall consist of a gearbox, drive belt or chain (with drive sprocket) and a 316 stainless steel chain guard. The gearbox shall be parallel in-line helical type, AGMA III. For belt systems, the belt should be made of banded chloroprene rubber with aramid reinforcement. For chain systems, the drive sprocket shall be nylon and the chain shall be nylon with 18-8 stainless steel link pins. Alternatively, for chain systems, the chain shall be acetal with 316 stainless steel link pins.

F. Support Frame and Cover

1. The support frame shall be structural welded, 316 stainless steel construction. The support frame shall include welded 316 stainless steel base plates for backwash spray pump, drive gear box, center shaft bearing house and support wheels. Carbon steel construction is not acceptable. The upper part of the filter shall be furnished with a cover consisting of a 316 stainless steel frame, 316 stainless steel cables, and lockable/individually removable aluminum lids.

G. Backwash Cleaning and Pumping System

1. Each filter unit shall be provided with two backwash pumps that draw filter effluent through the cloth as the media rotates past the fixed backwash shoe and are capable of pumping the backwash water to the headworks return box.
 - a. Backwash/waste pumps shall be self-priming end suction centrifugal pumps and shall be provided with a minimum 5 HP, 460 volt, 3 phase, 60 Hz motor and operate at 1750 rpm.
 - b. Design duty condition: 130 gpm, 45 ft TDH
 - c. Pumps shall be provided in accordance with Section 11100 – Pumps, General

2. The backwash system shall include 316 stainless steel backwash shoe supports with 316 stainless steel spring, backwash shoes and reinforced PVC flexible hose with stainless steel hose clamps.
3. Backwash and solids waste valves shall be full port ball valves.

2.4 ELECTRICAL AND CONTROL SYSTEMS

- A. General: The Supplier shall design and provide an electrical, instrumentation and control system for the system to allow for automated operation. The electrical, instrumentation and control system shall consist of local control panels (LCP), specialty instruments, Programmable Logic Controller (PLC), and control system configuration. The electrical, instrumentation and control system shall be coordinated with the overall treatment plant electrical instrumentation and control system provided under other sections of the Contract Documents. As described in the Contract Documents, the Supplier and Contractor shall coordinate the components supplied and installed under other parts of the Contract Documents. The Filter Control Panel shall have the capability to communicate with the Plant SCADA system via a MODBUS TCP communication port. Any and all analog or discrete signals connection to the Disk Filter Control Panels shall be available to the Plant SCADA system via these communication ports.
- B. Local Control Panels: Local control panels shall be supplied in accordance with Section 16145 – Cabinet and Enclosures. Local control panels shall be provided to provide a convenient location to mount control switches, display equipment status and alarms, display process analyzer values, and locations for wiring terminations. LCP shall be provided as described below:
 1. Filter Control Panels (FIL1-LCP-01 AND FIL2-LCP-01): A LCP shall be provided to be mounted on the filter area platform for the drives and the backwash supply pumps. The LCP shall include the following components:
 - a. Drive motors individual local-off-remote switch
 - b. Drive motors individual start button
 - c. Drive motors individual stop button
 - d. Drive motors individual alarm indicating light
 - e. Backwash pump individual local-off-remote switch
 - f. Backwash pump individual start/stop buttons
 - g. Backwash pump individual alarm indicating light
 2. The control system shall be equipped with a UL listed operator interface that provides control display screens. These screens shall be used by the operator to monitor and control filter status, setpoint and alarm information.
 - a. The interface shall allow the operator to adjust the following operating parameters:
 - 1) Backwash interval

- 2) Backwash duration
 - 3) Solids Waste interval
 - 4) Solids Waste duration
 - 5) Number of Backwashes between Solids Waste interval.
- b. The operator interface shall provide information to assist the Operator in assessing the status of the filter system. The interface screen shall display, at minimum, the following parameters:
- 1) Water level in the filter
 - 2) Time since last Backwash
 - 3) Time since last Solids Waste withdrawal
 - 4) Elapsed time on the Drive Motor
 - 5) Elapsed time on the Backwash/Waste Pumps
 - 6) Total Backwash time and cycles
 - 7) Total Solids Waste withdrawal time and cycles.
- c. The operator interface shall allow the operator to:
- 1) Initiate backwash
 - 2) Control all electric actuated valves
- d. The interface shall display the alarm history. The alarm history shall include the time and date of the most recent 25 alarms along with the description of the alarm.
- e. The interface shall also display current alarms, including the date, time and a description of the alarm.
- f. The interface shall display the time between Backwashes for the most recent 40 Backwashes.
3. All discrete control contact switches shall be dry contacts rated for a minimum of 10A at 120V. Contacts will be connected to the MCC or control system by others.
4. The local control system shall include a fused main disconnect, control transformer, branch circuit breakers, a time delayed level sensor relay for initiating backwash, and a timer for the backwash period.
- C. Specialty Instruments: The Supplier shall provide the following specialty instruments related to the filter system:
1. Level Sensor: Each filter tank shall be equipped with an adjustable differential water level sensor that will monitor the headloss across the filter media and will activate the backwash cycle. Refer to Section 13482, Instrument Index, for position of the level sensors in the filter tank.
 2. Turbidimeter: Manufacturer shall provide three turbidimeters; one shared influent turbidimeter and one effluent turbidimeter for each filter. The turbidimeters shall be of the type specified in Section 13400 – Instrumentation and Control System. One peristaltic pump shall be provided for each turbidity monitoring system to meet head requirements and shall be of the type specified in Section 13400 – Instrumentation and Control System.

2.5 MOTOR

- A. All electric motors including pump motors, drives, and valve actuators shall be AC motors rated 480 volt, 3-phase, 60 Hz, unless otherwise indicated, and shall conform to the requirements of Section 16222 – Motors.
- B. All motors shall have TEFC enclosures.
- C. Motors driven by variable frequency drives shall be variable frequency motors, as specified in Section 16222 – Motors.
- D. Motors which are 5 horsepower and larger shall have thermal protection and space heaters. All outdoor motors shall have space heaters.
- E. Motor Starters shall be furnished and provided in the respective Filter Control Panels.
- F. Automation of the filtration package shall be maximized. Manual control under normal operation shall be limited to those operations required for safety of personnel and equipment.

2.6 SPARE PARTS

- A. Each Filter Unit shall be supplied with the following spare parts:
 - 1. Replacement filter media for one 10 micron filter disk (entire disk)
 - 2. Replacement filter media for one 5 micron filter disk (entire disk)
 - 3. Shelf spare drive chain or belt
 - 4. Center tube seals

2.7 PROTECTIVE COATING

- A. All equipment, materials, and accessories provided are subject to the coating requirements of Section 09960 – Protective Coatings and shall be shop-painted as specified. Coatings shall be suitable for long-term service under the expected service conditions, and all wetted parts shall be of materials suitable for the service conditions specified. All wetted components located inside the filter basins shall be 316 stainless steel, fiberglass reinforced plastic (FRP), PVC, HDPE, plastic, or polypropylene.

2.8 MANUFACTURERS

- A. MANUFACTURER's Experience: The contractor shall provide products which have at least 5 years in operation. No equipment shall be considered which has an operating history of less than 5 years. Manufacturer shall have a minimum of 20 units in operation in the U.S. for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The disk filter manufacturer shall be responsible for all equipment provided under this section.

- C. Manufacturers or Equal:
 - 1. Aqua-Aerobic Systems, Inc.
 - 2. Five Star Filtration, LLC.
- D. Any use of substitute equipment shall not relieve the CONTRACTOR of providing a complete and operable system in complete conformance to the specifications, including all performance parameters and interfacing requirements.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. All equipment shall be delivered by the Supplier to the site ready for installation according to the schedule provided in the General Requirements.

3.2 INSTALLATION

- A. The Contractor shall install the filter system per the Supplier's written instructions and the drawings.
- B. An authorized service representative of the Supplier shall provide assistance to the Contractor during installation.

3.3 TESTING AND TRAINING

- A. Factory Inspections: The Supplier shall inspect control panels and equipment for required construction, electrical connection, and intended function.
- B. Factory Tests and Adjustments: The Supplier shall satisfactorily test all control panels and equipment prior to shipment.
- C. Inspection, Startup, and Field Adjustment: An authorized service representative of the Supplier shall visit the site to witness the following:
 - 1. Proper installation of the equipment.
 - 2. Proper inspection, checking, and adjustment of the equipment.
 - 3. Startup and field-testing for proper operation. The Supplier shall furnish all necessary lubricants for the initial startup and testing of the equipment.
- D. Functional Test: The Supplier shall perform functional testing on equipment in accordance with Section 01650 – Facility Start-up.
- E. Performance Testing
 - 1. The Supplier shall conduct performance testing in accordance with Section 01650 – Facility Startup.
 - 2. At least thirty (30) calendar days prior to start-up, CONTRACTOR shall submit a detailed plan for functional and performance testing during startup.

3. For each filter (5 and 10 micron) the CONTRACTOR shall be responsible for an independent, accredited laboratory to collect 24-hour composite inlet and outlet samples for two periods consisting of five consecutive day (10 days total per filter), including testing of the samples for total suspended solids at no cost to the DISTRICT.
4. Samples shall be collected using a time paced automated composite sampler.
5. Real time turbidity measurements shall also be recorded by the influent and effluent turbidity meters. The CONTRACTOR shall be responsible for ensuring that the turbidity meters are properly calibrated and operating properly.
6. The system shall be considered to have passed the performance test if the average outlet concentrations meet the following:
 - a. The effluent TSS produced by the filter meets all of the following conditions:
 - 1) Based on a minimum of two, 24-hour composite samples per week during the monthly period, TSS shall not exceed 30 mg/L.
 - 2) Based on a minimum of two, 24-hour composite samples per week, weekly average TSS shall not exceed 45 mg/L.
 - b. At the tested loading rate, the backwashing rate does not exceed the following as a percentage of influent flow:
 - 1) 10 micron media: 6%
 - 2) 5 micron media: 13%
7. If the system fails the performance test, the CONTRACTOR and the MANUFACTURER, shall correct any system deficiencies and re-test at no additional cost to the DISTRICT. No additional payment shall be made for adjustments, modifications, and re-testing.
- 8.

END OF SECTION

SECTION 11900 – FLUSHING TROUGH

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install three (3) flushing troughs to clean the flushing lanes of the Equalization Basin, complete and operable, in accordance with the Contract Documents.
- B. The flushing troughs shall include flushing tanks, backwall supports, anchors and bolts, bearings, proximity switch, filling valve, control panel, and all other components that are need for the flushing trough as suggested by the Manufacturer and required in this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. ASME
- C. ANSI

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 Submittals. Shop drawings shall including the flushing devices, their supports, bearings, anchoring details and trip switches, as well as drawings showing the layout of the units in the Equalization Basin, their identification numbers, position of switches, switches mounting details and any other pertinent information.
- C. Load Calculations: The Manufacturer shall provide the calculations for determination of both static and dynamic loading at the supports. Calculations shall meet the requirements listed on Drawing S-1 and shall be stamped by a Professional Engineer registered in the state of California.
- D. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- E. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. Manufacturer's written guarantee that the flushing trough system will effectively flush the sediments deposited in the flushing lanes using only one (1) flush under normal bottom loading conditions
2. Manufacturer's Certificate of Proper Installation
3. Functional Test Certification
4. Factory performance test reports
5. Special shipping, storage and protection, and handling instructions
6. Manufacturer's printed installation instructions
7. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
8. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. The equipment shall be warranted for a period of five (5) years against defects in workmanship and materials under normal use. If the equipment should fail during the warranty period due to a defective part, it shall be replaced and the units restored at no expense to the OWNER.
2. Unless otherwise specified in this Section, warranty shall be provided for the equipment specified in this section as required in Section 01740 - Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 0.5 person-days for installation assistance and inspection,
2. 0.5 person-days for functional and performance testing
3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – EQ2-TRS1, EQ2-TRS2, AND EQ1-TRS1

A. The requirements of Section 11000 – Equipment General Provisions apply to this section.

2.2 DESIGN REQUIREMENTS

- A. Design requirements are listed in Table 1 below.

Table 1 - Flushing Trough Design Requirements

	EQ Storage Basin No. 1	EQ Storage Basin No. 2
Quantity	1	2
Minimum flushway length (feet)	32.2	48.8
Minimum flushway width (feet)	23.5	16
Minimum volume per flush, each (gal)	360	320
Minimum specific volume (gal/ft)	16	20

2.3 MATERIALS OF CONSTRUCTION

- A. Flushing Trough: Each flushing trough shall be constructed of Type 316 stainless steel. The shell thickness must be designed to withstand both static and dynamic loading experienced under normal operation and installation conditions. The shell thickness shall have a minimum thickness of 1/8-inch.
- B. Supports: Each unit includes two Type 316 stainless steel supports anchored to the backwall of the flushing lanes using epoxy anchors, with hardware fabricated entirely of Type 316 stainless steel. Supports shall be at least 3/8-inch thick. Contractor shall be responsible for coordinating with the Manufacturer prior to construction of the equalization basin to install anchorage hardware into the equalization basin walls.
- C. Bearings: Bearings shall be tapered spherical double roller bearings with locking sleeve. Each bearing shall be completely enclosed in a submersible housing made of corrosion resistant material. The housing shall be equipped with a removable end cap and double lip seal on the shaft side. The bearings shall be factory installed and test, and permanently lubricated under normal operating conditions.

2.4 CONTROLS AND OPERATION

- A. Position Switches: The position switch shall be an inductive proximity switch that is watertight and directly mounted on the support structure. The position switch shall be manufactured by Pepperl+FUCHS, model #NJ15-30GK-N, or equal.
- B. Solenoid Valve: The solenoid valve controlling the filling of the flushing trough shall have a body made of brass, sized 2-1/2 inches and explosion proof and shall meet the requirements of Section 13400 Instrumentation and Controls.
- C. Operating Sequence
1. Once the flushing cycle is initiated, the solenoid valve controlling the filling of the selected flushing trough opens. Once filled, the trough tips under the sole effect of gravity. As it tips, it activates the position switch mounted on the side support. The signal from the position switch activates the closure of the solenoid valve. The

same procedure is repeated until the last solenoid is closed, thus completing the flushing cycle of the basin. Control of the flushing troughs shall be integrated into the plant control SCADA system. Flushing in each basin shall have separate control functions.

2.5 PROTECTIVE COATING

- A. Materials and equipment shall be coated in accordance with Section 09960 – Protective Coatings and the Contract Documents.
- B. Contractor shall be responsible for providing written confirmation from the Manufacturer that the proposed coating system(s) is appropriate for the product water and environment.

2.6 SPARE PARTS

- A. The Contractor shall obtain from the manufacturer a list of suggested spare parts of all items of each piece of equipment subject to wear. Furnish spare parts suitably packaged and labeled in a box in the same manner as required for tools.

2.7 MANUFACTURERS

1. Manufacturer's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized flushing troughs for a minimum of 5 years. Manufacturer shall have no fewer than 10 successful installations that have been in operations for no fewer than 5 years in the United States or Canada. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the Manufacturer's recommendations and the Contract Documents.
2. Manufacturers shall maintain a well-established, authorized, local service agency with sufficient spare parts and personnel to respond within 48 hours to any service calls.
3. Unit Responsibility: The flushing trough MANUFACTURER shall be responsible for all equipment provided under this section.
4. Manufacturers or Equal:
 - a. John Meunier Inc., Hydrovex SFT
 - b. WSG & Solutions

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

A. General

- 1. Provide testing in accordance with Section 01650 - Facility Start Up.

B. Factory Testing

- 1. Flushing trough must be assembled and balance at the manufacturing plant prior to shipment. A factory balancing and testing may be required to be witness by the ENGINEER at the ENGINEER's discretion. The CONTRACTOR shall notify the OWNER at least 21 days in advance of the scheduled factor testing date.
- 2. Certified factory test reports shall be submitted.

C. Functional Testing:

- 1. Each flushing trough shall be field tested in the presence of the Engineer to verify proper alignment and operation without defects and that all components perform their specified functions satisfactory.

D. Performance Testing

- 1. Performance testing of the full-scale equipment shall be required in accordance with Section 01650 – Facility Start Up.

END OF SECTION

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SECTION 13115 – CORROSION PROTECTION SYSTEM

PART 1 - GENERAL

1.1 THIS SECTION INCLUDES

- A. The WORK of this Section includes providing a complete galvanic cathodic protection system for metallic 20-inch to 28-inch diameter valves and fittings to be installed on non-metallic pipe as part of the upgrades to the Sausalito – Marin City Sanitary District's Treatment Plant. Fittings shall have a shop applied dielectric coating.
- B. Electrical Isolation of above structures from adjacent metallic structures, reinforcing steel, structures of dissimilar metal, conduits, and all other metallic components that may impact the operation of the corrosion protection system.
- C. Electrical bonding of all non-insulated, non-welded pipe or mechanical joints.
- D. Testing the system after installation.
- E. Cleanup and restoration of work site.

1.2 REQUIREMENTS

- A. If the products installed as part of this Section are found to be defective or damaged or if the WORK of this Section is not in conformance with these Specifications then the products and WORK shall be corrected at the CONTRACTOR's expense.
- B. The WORK also requires that one Supplier or Subcontractor accept responsibility for the WORK as indicated, but without altering or modifying the CONTRACTOR's responsibilities under the Contract Documents.
- C. The WORK also requires coordination of assembly and installation between the contractor and any corrosion protection material supplier or subcontractor.

1.3 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - 1. Site Safety and Regulatory Requirements
 - 2. Section 09960 Protective Coatings
 - 3. Piping
 - 4. Excavation, Trenching, Backfilling, and Compacting
 - 5. Cast-In-Place Concrete

1.4 REFERENCED SPECIFICATIONS, CODES, AND STANDARDS

- A. The WORK of this Section shall comply with the current editions of the following codes and standards:
1. ASTM ASTM International
 - a. B3 Standard Specification for Soft or Annealed Copper Wire
 - b. B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - c. B418 Standard Specification for Cast and Wrought Galvanic Zinc Anodes
 - d. D1248 Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
 - e. D2220 Standard Specification for Polyvinyl Chloride (PVC) Insulation for Cable and Wire
 2. NACE NACE International, the Corrosion Society
 - a. RP0375 Wax Coating Systems for Underground Piping Systems
 - b. SP0169 Standard Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
 - c. TM0497 Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems
 3. UL Underwriters Laboratory
 - a. 83 Thermoplastic-Insulated Wires and Cables
- B. Whenever the Drawings or these Specifications require a higher degree of workmanship or better quality of material than indicated in the above codes and standards, these Drawings and Specifications shall prevail.

1.5 PERMITS AND JOB ACCESS

- A. The CONTRACTOR shall contact Underground Service Alert prior to commencing construction to locate existing utilities in the area of construction. Existing utilities include, but are not limited to, water lines, gas lines, telephone, street lights, sewer and storm drains, and overhead and underground electric utilities.
- B. Traffic control shall satisfy the requirements of the governing locality.

1.6 QUALITY ASSURANCE

- A. Installation of the corrosion protection equipment shall be performed by individuals having at least 5 years of experience in the installation of the corrosion protection equipment described herein.

1.7 SUBMITTALS

- A. The following shall be submitted to the ENGINEER prior to any equipment installation.
 - 1. Catalog cuts, bulletins, brochures, or data sheets for all materials specified herein.
 - 2. Certification that the equipment and materials proposed meets the Specifications and the intent of the Specifications.
 - 3. Written certification of experience required.
 - 4. Schedule, including the expected start date and planned completion date.
- B. The following shall be submitted to the ENGINEER after completion of the WORK.
 - 1. Wire connection testing.
 - 2. System check-out report.
 - 3. Record drawings shall be submitted to and approved by the ENGINEER before the WORK is considered complete.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials installed must be new. All equipment and materials supplied shall be similar to that which has been in satisfactory service for at least 5 years.

2.2 GALVANIC ANODES

- A. Zinc anodes shall be "High Purity" cast zinc anodes in accordance with ASTM B418, Type II.
 - 1. Ingot Weight: 48 pounds.
 - 2. Packaged Length: 38 inches.
- B. Galvanic anodes shall be prepackaged in a cloth bag containing backfill of the following composition: 75% gypsum, 20% bentonite, and 5% sodium sulfate.
- C. The anodes shall be placed where indicated on the Drawings.
- D. Anode Wire: The wire attached to the anodes shall be stranded, single conductor copper in conformance with ASTM B3 and ASTM B8. The wire shall be THHN conforming to the requirements of ASTM D2220 and rated for 600 volts. Wire size shall be minimum No. 10 AWG. Connection of wire to the anode shall have a pulling strength that exceeds the wire's tensile strength.
- E. Anode wires shall be of one continuous length without splices from the anode connection to the test station panel board.

2.3 CONCRETE TRAFFIC VALVE BOXES

- A. Traffic valve boxes shall be rated to withstand AASHTO H20 traffic loading. The traffic valve boxes shall be G5 Utility Boxes, as manufactured by Christy Concrete Products, Inc.; No. 3RT Utility Box, as manufactured by Brooks Products; or approved equivalent. Traffic box covers for test stations shall be cast iron with welded bead legend and labeled "CP TEST" or "ANODE," as required.

2.4 SHUNTS FOR GALVANIC ANODES

- A. Shunts shall be 0.01-ohm, 5-amp, manganin wire type, as indicated. Shunts shall be Type RS, as manufactured by Holloway, or equivalent.

2.5 TEST STATION PANEL BOARDS

- A. Panel boards shall be made of 1/4-inch thick phenolic plastic sized as indicated on the Drawings.
- B. Connection hardware shall be nickel plated brass. All connections shall be double nutted bolts with lock washers.

2.6 WIRES

- A. Conductors shall consist of stranded copper of the gauge indicated on the Drawings. Wire sizes shall be based on American Wire Gauge (AWG). Copper wire shall be in conformance with ASTM B3 and ASTM B8.
- B. All wires terminating in a test station shall have a wire identifier attached within 4 inches from the end of wire at the terminal board, prior to backfill, as specified under "Wire Identification."
- C. Wires shall be connected to the metallic pipe fittings by exothermic welding. Supply wires with formed copper sleeve on each end of wire that will be exothermic welded.
- D. Wire Type and Colors: As shown on the Drawings.
 - 1. High molecular weight polyethylene (HMWPE) wire shall be rated for 600 volts and shall conform to ASTM D1248.
 - 2. THWN wire with PVC insulation and nylon jacket shall be rated for 600 volts and shall conform to UL 83 and ASTM D2220.

2.7 EXOTHERMIC WELDS

- A. Exothermic welds shall be in accordance with the manufacturer's recommendations. Exothermic welds shall be Cadweld, as manufactured by Erico Products, Inc.; Thermoweld, as manufactured by Continental Industries, Inc.; or approved equivalent. Duxseal packing, as manufactured by Johns-Manville, or approved equivalent shall be used where necessary to prevent leakage of molten weld metal.
- B. The shape and charge of the exothermic weld shall be chosen based on the following

parameters:

1. Fitting, valve, or pipe material
2. Fitting, valve, or pipe size
3. Wire material/size and requirement for sleeves
4. Number of strands to be welded
5. Orientation of weld (vertical or horizontal)

2.8 WELD CAPS

- A. Weld caps shall be Royston Handy Cap, as manufactured by Royston Laboratories, Inc.; Thermite Weld Cap, as manufactured by Phillips Petroleum Co.; or approved equivalent.

2.9 PETROLATUM WAX TAPE

- A. Petrolatum wax tape system shall be Trenton Primer and #1 Wax-tape, as manufactured by Trenton Corp.; or Denso Paste and Densyl Tape, as manufactured by Denso North America, Inc.; or approved equivalent.

2.10 WIRE IDENTIFIERS

- A. Wire identifiers shall be the wrap-around type with a high resistance to oils, solvents, and mild acids. Wrap-around markers shall fully encircle the wire with imprinted alpha-numeric characters for pipe and anode identification. The letters and numbers shall be printed, minimum 3/16 inch in size.

PART 3 - EXECUTION

3.1 STORAGE OF MATERIALS

- A. All materials and equipment to be used in construction shall be stored in such a manner to be protected from detrimental effects from the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or other method as appropriate.

3.2 EXCAVATION AND BACKFILL

- A. Buried wires shall have a minimum cover of 24 inches.
- B. Caution tape shall be installed above buried wire. Caution tape shall be installed a minimum of 6 inches above underground wires.
- C. Anode wire identification tags shall be placed on the wires prior to backfilling.

3.3 GALVANIC ANODE INSTALLATION

- A. Prepackaged anodes shall be installed at the locations indicated. Plastic or paper wrapping shall be removed from the anode prior to lowering the anode into the hole. Anodes shall not

be suspended by the lead wires. Anodes shall be backfilled with native soil. Upon completion of compaction of backfill to the top of the anode, and immediately prior to filling the hole and compacting the backfill to the surface, a minimum of 10 gallons of water shall be poured into the hole to saturate the prepackaged anode backfill and surrounding soil.

- B. Backfilling with native soil shall proceed in 6-inch lifts, compacting the soil around the anode during each lift until the backfill has reached grade. Damage to the canvas bag, anode-to-wire connection, copper wire, or wire insulation will require replacement of the entire assembly. Anodes shall not be backfilled prior to inspection and approval.
- C. Anode lead wires shall be installed as shown in the Drawings, and attached to the panel board.

3.4 TEST STATIONS

- A. Test stations shall be installed at the approximate locations shown on the drawings. Flush mounted test stations shall be located behind the curb and other areas not subject to vehicular traffic. The CONTRACTOR shall field verify final location of the test stations. Wire identifiers shall be placed on all wire prior to backfill and installation of test stations.

3.5 WIRES

- A. Buried wires shall be laid straight without kinks. Each wire run shall be continuous in length and free of joints or splices. Care shall be taken during installation to avoid punctures, cuts, or other damage to the wire insulation. Damage to insulation shall require replacement of the entire length of wire at the CONTRACTOR's expense.
- B. At least 18 inches of slack (coiled) shall be left for each wire at each flush-to-grade test station. Wire slack shall be sufficient to allow removal of wire extension for testing. Wire shall not be bent into a radius of less than 2 inches.

3.6 EXOTHERMIC WELD CONNECTIONS

- A. The CONTRACTOR shall inspect both the interior and exterior of the metallic fitting/valve or pipe to confirm that all coatings and linings removed or damaged as a result of the welding have been repaired. The CONTRACTOR shall furnish all materials, clean surfaces, and repair protective coatings and linings damaged as a result of the welding. Repair of any coating or lining damaged during welding shall be performed in accordance with coating or lining manufacturer's recommendations.
- B. Exothermic weld connections shall be installed in the manner and at the locations indicated. Coating materials shall be removed from the surface over an area of sufficient size to make the connection. The surface shall be cleaned to bare metal by grinding or filing prior to welding the conductor. The use of resin impregnated grinding wheels will not be allowed. A copper sleeve shall be fitted over the conductor. Only enough insulation shall be removed such that the copper conductor can be placed in the welding mold.
- C. The CONTRACTOR shall be responsible for testing all test lead and bond wire welds. The ENGINEER, at his or her discretion, shall witness these tests.
- D. After the weld has cooled, all slag shall be removed and the metallurgical bond shall be tested for adherence by the CONTRACTOR. A 22-ounce hammer shall be used for

adherence testing by striking a blow to the weld. Care shall be taken to avoid hitting the wires. All defective welds shall be removed and replaced.

- E. After backfilling, all test lead pairs shall be tested for broken welds using a standard ohmmeter. The resistance shall not exceed 150% of the theoretical wire resistance as determined from published wire data.
- F. All exposed surfaces of the copper and steel shall be covered with a weld cap as indicated.

3.7 JOINT BONDS

- A. Bond wires shall be provided across flexible couplings and all nonwelded joints, as necessary to ensure electrical continuity, except where insulating joints have been installed to provide electrical isolation. Joint bonds shall be of the size and number shown on the drawings and installed as indicated. The bond wires shall be at least 18 inches long and shall be installed so as to allow for movement of at least 2 inches in the pipe joint. The wire shall be attached by exothermic welding. At least 2 bonds shall be provided between all discontinuous joints.

3.8 PETROLATUM WAX TAPE SYSTEM APPLICATION

- A. Petrolatum wax tape system shall be applied on insulating joints and as indicated in the drawings. Petrolatum tape system shall be applied in accordance with NACE RP0375 and these Specifications. The materials shall be applied according to the Manufacturer's recommendations.
- B. All loose scale shall be removed from the surface to be coated with hand tools (wire brush, scraper, and rags). Debris and moisture shall be wiped from surface with a clean rag. Petrolatum tape shall be applied immediately after applying the primer, using a 1-inch overlap. A spiral wrap shall be used and slight tension shall be applied to ensure that there are no air pockets or voids. After applying the tape, the applicator shall firmly press and smooth out all lap seams and crevice areas. The tape shall be in tight intimate contact with all surfaces.

3.9 WIRE IDENTIFIERS

- A. All wires shall be coded with wire identifiers.
- B. Wire identifiers shall be placed on the wires prior to backfill.

3.10 WIRE CONNECTIONS

- A. After installation, all wire connections shall be tested at the test station locations by the CONTRACTOR to ensure that they meet the requirements and intent of the Contract Documents.

3.11 SYSTEM CHECKOUT

- A. Upon completion of the installation, the CONTRACTOR shall provide testing of the completed system by a qualified corrosion technician and the data shall be reviewed by a Corrosion Engineer to ensure conformance with the Contract Documents and NACE SP0169.

- B. The testing described herein shall be in addition to and not substitution for any required testing of individual items at the manufacturer's plant and during installation.
- C. Testing shall be performed at all test leads of all test stations and at the locations of exposed pipe as soon as possible after installation of the cathodic protection system.
- D. Testing shall include the following and shall be conducted in accordance with NACE TM0497:
 - 1. Measure and record native pipe-to-soil and anode-to-soil potentials at all test locations.
 - 2. Confirm electrical continuity of the valves and fittings in accordance with this Section.
 - 3. Measure and record the "On" and "Instant Off" structure-to-soil potentials at each location.
 - 4. Measure and record the current output of each anode.
- E. Test results shall be analyzed to determine compliance with NACE SP0169.
- F. The CONTRACTOR shall provide a written report, prepared by the Corrosion Engineer, documenting the results of the testing and recommending corrective work, as required to comply with the Contract Documents. Any deficiencies of systems tested shall be repaired and re-tested by the CONTRACTOR at no additional cost to the OWNER.

** END OF SECTION **

SECTION 13130 – FLAT CIRCULAR CLARIFIER COVERS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish all labor, materials, and equipment required to provide and erect one (1) extruded aluminum beam supported flat cover with all appurtenances for Primary Clarifier #2 as indicated on the contract drawings and as specified herein. Each cover shall be designed, furnished, delivered, and installed complete with beam supports, panels, all required fasteners, sealant and gaskets, anchor bolts, access hatches, duct and inlet curb, expansion anchors, and all accessories and appurtenances specified herein and indicated on the Contract Documents, or as otherwise required for a complete installation.
- B. Provisions shall be made for the access hatches, scum skimming equipment, weir covers, and other components indicated on the Contract Documents. The covers shall be designed so as not to interfere with the operation of the scum skimming equipment at design loads.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASCE 7 Minimum Design Loads for Buildings and Other Structures
- B. ASCE 7-93 Specification for the Design of Cold-Formed Stainless Steel Structural Members
- C. ASTM C509 Standard Specifications for Cellular Elastomeric Preformed Gasket and Sealing Material
- D. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- E. Aluminum Association Specification for Aluminum Structures
- F. Aluminum Association Aluminum Standards and Data
- G. Federal Specification TT-S-00230, C

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 – Submittals, CONTRACTOR shall submit the following:
 - 1. Complete structural calculations showing the governing stresses in all members and connections, and detailed shop drawings. Calculations verify conformance to deflection limits for structural members as well as walking surface. Preliminary

drawings shall be provided. Final Drawings and calculations shall bear the stamp of California PE.

2. Records certifying the satisfactory inspection of all structural welds of aluminum components shall be submitted prior to delivery of the fabricated materials.

C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.

D. Tools: If required, special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory or field testing performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01740 - Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01730 - Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 2 person-days for installation assistance and inspection,
2. 2 person-days for functional and performance testing
3. 2 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

- A. The cover shall consist of a near flat deck comprised of panels and supported by beams located above the cover. The cover shall be clear-span and self-supporting from the peripheral structure.
- B. Complete design and construction of the beam cover and all appurtenances as specified herein shall be performed by one single MANUFACTURER.
- C. All welding of aluminum shall be performed in the shop in accordance with the recommendations of the American Welding Society and the Aluminum Association, Section 7. Welds shall be free of porosity, cracks, holes, and entrapped slag. Field welding of aluminum will not be acceptable.
- D. All support beams shall be above the cover system as indicated in the Contract Drawings..

2.2 FLAT CIRCULAR CLARIFIER COVER

A. General

- 1. The cover will be installed on a Primary Clarifier which receives screened and degrittied wastewater from the headworks. Odor control fans will be used to maintain a partial vacuum beneath the cover to collect and convey foul air to the bio scrubbers for treatment. The cover and all materials used therein shall be resistant to corrosion and shall be certified by the cover MANUFACTURER as fully suitable for continuous exposure to water saturated air containing hydrogen sulfide, mercaptans, and ammonia at temperatures ranging from 20 degrees F to 100 degrees F.
- 2. The covers shall be fabricated, assembled, delivered, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations furnished by the MANUFACTURER unless exceptions are noted by the ENGINEER.
- 3. The flat panel cover shall conform to the specified dimensions and shall consist of flat aluminum interlocking panels.
- 4. The beam cover shall be designed to accommodate all ductwork, access hatches, clarifier drive mechanism, and all other pertinent items as required.
- 5. The system shall be self-supported from the basin walls as indicated on the drawings. Ponding of water on top of the cover will not be acceptable.
- 6. An elastomeric weather seal gasket shall form a continuous seal along all panel edges. The seal shall be substantially watertight. The gaskets shall be fully enclosed to prevent ultraviolet exposure.
- 7. The top surface of the panels shall be flush and free of tripping hazards such as bolt heads or fasteners of any type.

8. The flat panels shall have an integral bi-directional slip resistant surface which extends a minimum of 0.1 inch above the panel surface. A raised surface without the use of texturing to achieve slip resistance is not acceptable. The use of checkered plate, paint, tape, sand blasting or other applied systems to achieve the slip resistant surface is expressly prohibited.
9. Dissimilar materials which are not compatible with the aluminum cover shall be physically separated or insulated by means of elastomeric gaskets.
10. Access hatches:
 - a. Shall be provided as indicated on the drawings and shall be subject of the structural design criteria specified herein. Access to any location under the cover shall be gained through access hatches and frames or integral gear hinged access hatch panels.
 - b. The access hatch panels shall have the identical properties as the rest of the aluminum cover including loads, deflection, and slip resistance specifications. The access-hinged panels shall be the full panel width. The length of the access panel shall be clearly indicated on the shop drawings. While in the closed position the hatches will be completely flush therefore posing no tripping hazard and shall be sealed with a gasket or by other acceptable means. In the open position the panel shall lie flat on the cover and will not need a hold open device. Two recessed handles or equivalent lifting means shall be provided at each end of each removable panel. Temporary guardrail and sockets designed according to OSHA standards shall be provided at the perimeter of the supports for hatch panels. When panels are removed, there shall be a clear span between the beam supports. No beams or box beams shall remain in the basins.
11. Hinged weir covers: Shall be provided as shown on the drawings and around the circumference of the clarifiers on alternating panels. The weir covers shall be easily accessible and shall allow full access to the weirs for cleaning and maintenance. The weir covers shall be skid resistant as specified above.

B. Design Loading Requirements

1. The beam supported flat cover shall be designed in accordance with "Aluminum Design Manual" as published by the Aluminum Association and designed for full dead load plus live load in accordance with applicable local codes.
2. The load cases to be considered shall be those described below:

Uniform Live Load	50 psf
Unbalanced Live Load	100 percent of the Uniform Live Load acting over one half of the cover with no live load on the other half
Wind Load	As specified on Drawing S-1 - Wind Design Criteria
Vacuum/Pressure Load	1 inch water column

3. Load Combinations: The loads described above shall be applied to the cover in the following combinations
 - a. Dead Load
 - b. Dead Load, Uniform Live Load, and Vacuum Load
 - c. Dead Load, Unbalanced Live Load, and Vacuum Load
 - d. Dead Load, Wind Load, and Pressure Load
 - e. Dead Load, Uniform Live Load, and Wind Load
 - f. Dead Load, Unbalanced Live Load, and Wind Load
4. Temperature: The load combinations listed above shall be considered for a temperature change of 100 degrees F below the installation temperature and 100 degrees F above the installation temperature, and for a material temperature range of 40 degrees F below to 60 degrees F above zero.
5. Panel Design Load: In addition to the above mentioned loads and load combinations, the aluminum panels shall be designed for a 400 pound load distributed over one square foot at any location. This load is to be taken as acting separately and not simultaneously with other design loads.
6. For the above loads and load combinations, the deflection of all components (structural and cladding) shall not exceed $L/240$ with L equal to the short span of the component. This deflection limit applies not only to the flat cover as a whole, but also to the skin of the cover spanning between the supporting edges of each panel or module. Calculations by a registered Professional Engineer shall be provided at the time of submittal to ensure that this requirement has been met.
7. Beams shall be designed to resist all loads imposed during erection without exceeding allowable stresses or causing permanent deformation.
8. Primary horizontal thrust shall be carried by members so that no horizontal loads due to the coefficient of friction (not to exceed 10 percent of the maximum load) are transferred to the walls. All connections shall be designed to permit expansion and contraction of the cover.
9. The dead weight of the flat covers shall not exceed 150 pounds per panel; each panel shall be easily removable with a lifting force equal to the dead weight of the panel, provided that the odor control fans are turned off. The dead weight of access hatches shall not exceed 100 pounds.

C. Appurtenances

1. Cover to clarifier mechanism Interface: The cover interface with the clarifier drive mechanism and center platform shall be designed to minimize air leakage and facilitate maintenance of the drive mechanism. The cover MANUFACTURER shall coordinate with the clarifier mechanism MANUFACTURER for interface of the cover and the clarifier drive mechanism.
2. Odor Control Duct Nozzle: Provide as indicated on the Drawings. The MANUFACTURER shall provide ANSI 16.1, Class 25 flanges at the indicated

locations. All joints between the aluminum connection flange and the panel shall be suitably reinforced, gasketed, and permanently sealed weather tight.

3. Make-up Air Vents: Provide aluminum make-up air vents as indicated on the drawings. The MANUFACTURER shall provide ANSI 16.1, Class 25 flanges. All joints between the air inlet ducts and the panel shall be suitably reinforced, gasketed, and permanently sealed weather tight.

2.3 MATERIALS OF CONSTRUCTION

- A. All metallic material used in the construction of the covers shall be aluminum of stainless steel that is suitable for the corrosive conditions. Materials of construction shall be as follows:

Structural Shapes or Support Members	Aluminum Extrusion, 6061-T6
Panels	6063-T6, 6061-T6, not less than 0.1 inch thick
Bolts and Fasteners	6061-T6 or 7075-T73 aluminum or 316 stainless steel. The use of plastic fasteners is prohibited
Sealant	Shall be resistant to ozone and ultraviolet light, and conform with Federal Specification TT-S-00230C
Gaskets	All gaskets shall be Santoprene or Neoprene conforming with ASTM C-864 or ASTM C509, resistant to ozone, and shielded from exposure to ultraviolet light
Access Hatches	6061-T6, 5052-H36, 5086-H34, or 3003-H16 aluminum, not less than 0.09 inch thick
Duct and Air Inlet Curb	6063-T6, 6061-T6, 5052-H36, 5086-H34, or 3003- H16 aluminum, not less than 0.125 inch thick

- B. All exposed surfaces of the cover shall be sandblasted in accordance with commercial sand blast SSPC-SP-6-63 which produces an AA-M44 (coarse matte) finish. Sandblasting of cover system is to reduce glare from cover surface only and shall not be an acceptable means to achieve skid resistance.

2.4 SPARE PARTS

- A. The Contractor shall obtain from the manufacturer a list of suggested spare parts of all items of each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, bearings, etc. Furnish spare parts suitably packaged and labeled in a box in the same manner as required for tools.

2.5 MANUFACTURERS

- A. MANUFACTURER's Responsibility: The MANUFACTURER of the aluminum flat beam supported cover shall provide and erect the cover in the field and shall certify that the

cover and all appurtenances have been properly erected in conformance with the Contract Documents and the MANUFACTURER's requirements.

- B. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized extruded aluminum beam support flat covers for a minimum of 5 years. The MANUFACTURER shall have furnished at least 5 aluminum flat beam covers of the type and size specified herein for municipal wastewater treatment which have been in successful operation for at least 3 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- C. Unit Responsibility: The cover manufacturer shall be responsible for all equipment provided under this section.
- D. Manufacturers or Equal:
 - 1. Hallsten
 - 2. CST
- E. Any use of substitute equipment shall not relieve the CONTRACTOR of providing a complete and operable system in complete conformance to the specifications, including all performance parameters and interfacing requirements.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. The MANUFACTURER of the aluminum flat beam supported covers shall erect the covers in the field and shall certify that the covers and all appurtenances have been properly erected in conformance with the MANUFACTURER's requirements. Each cover shall be assembled and installed by a trained field crew employed by the cover MANUFACTURER. Mechanics shall be skilled and experienced in fabrication and erection of aluminum structures with a minimum of 5 installations under satisfactory operation for a minimum of 3 years.
- B. All cover components shall be fabricated at the MANUFACTURER's factory. Field refabrication of structural components or panels will not be accepted. Forcing of the structure to achieve "fit-up" will not be accepted.
- C. Field welding of aluminum shall not be allowed.

- D. After installation and field load testing, and completion of all connections, the exterior surfaces of each cover shall be thoroughly cleaned to the satisfaction of the CONSTRUCTION MANAGER in accordance with the MANUFACTURER's recommendations.

3.3 TESTING

- A. Factory Testing: MANUFACTURER shall perform a shop air tightness test and certification for the cover configuration proposed. The air tightness test shall be performed in accordance with the "Procedural Standards for Testing, Adjusting and Balancing of Environment System" as published by the National Environmental Balancing Bureau (NEBB). The test shall be conducted and witnessed by a NEBB certified technician. The method of testing, test apparatus and proposed contents of the test report shall be submitted to the ENGINEER for approval. Subsequent to the receipt of ENGINEER'S approval, the MANUFACTURER shall set up testing protocol and schedule the test. The MANUFACTURER will provide the CONSTRUCTION MANAGER with at least 48 hour notice prior to the scheduled test. A report of the test shall be prepared by a certified technician and shall be sealed with the NEBB seal. The report shall include a description and illustration of the cover configuration, a description and illustration of the test apparatus and a report of the results. The cover shall maintain an air intrusion leakage rate not to exceed 0.2 cfm per square foot at an applied negative pressure of 0.2 inches of water column for a 5-minute duration. The MANUFACTURER may propose field testing in lieu of factory testing. A field testing plan shall be submitted by the MANUFACTURER to the CONSTRUCTION MANAGER for review and approval. The CONTRACTOR shall be responsible for making any modifications required, including retesting, in order for the cover to satisfy the leakage requirements, at no additional cost to the DISTRICT.
- B. Functional Testing: All tests shall be conducted in a manner acceptable to the ENGINEER and shall be repeated as many times as necessary to demonstrate compliance with specified requirements. Following completion of cover installation, at least two panels of each cover as selected by the ENGINEER shall be field load tested. One panel shall be subjected to a concentrated load consisting of cloth sacks of suitable size, containing earth or sand, applied on a 1 square foot area of the test panel in a location where it will produce maximum flexure and deflection. The concentrated load shall be not less than 1.5 times the concentrated panel design load specified. The second test panel shall be subjected to a uniform test load of 1.5 times the specified uniform design load applied over the entire surface of the panel. The test panels shall withstand the specified field test loads without damage, slippage, or permanent distortion. If either test panel fails to meet the specified requirements, all panels shall be removed, replaced with new panels, and selected panels shall be retested. Panel removal, replacement, and retesting shall be performed at no additional cost to the OWNER.

END OF SECTION

SECTION 13200 – DUMPSTER BIN

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one (1) dumpster bin for disposal of screened solids and grit, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ANSI Z 245.3 Safety Requirements for the Stability of Refuse Bins
- B. ASTM A36 Standard Specification for Carbon Structural Steel
- C. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- D. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- E. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

1.3 CONTRACTOR SUBMITTALS

- A. General: Contractor shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 - Submittals.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 - Submittals.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Factory performance test reports

3. Special shipping, storage and protection, and handling instructions
4. MANUFACTURER's printed installation instructions
5. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
6. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section 01740 - Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

1. Not required.

PART 2 PRODUCTS

2.1 GENERAL – MHA-EQP2

- A. A dumpster container shall be provided compatible with the District's refuse company's requirements. Contractor shall be responsible for confirming requirements with the refuse company.

2.2 MATERIALS OF CONSTRUCTION

- A. Dimensions shall not exceed 6.5' L x 6' W x 4' (front) H. Internal area shall yield a minimum of 6 cubic yards of sludge storage.
- B. Container shall be constructed of A-36 carbon steel plate with the following thicknesses:
 1. Sides/Floors: 12 Ga.
 2. Pockets/Gussets: 7 Ga.
 3. Rails/Skids: 10 Ga.
- C. Container shall have 4"x 8" gusseted fork channels reinforced at pick-up points
- D. Container shall have one 1" threaded drainage port on the bottom of the wall. The port shall have a 3" hose cam connection with cap and chain.
- E. Wall gussets shall be 7 gauge formed plate.
- F. Hot-rolled structural steel shapes and plates shall be ASTM A36.
- G. Hot-rolled carbon steel sheet and strip structural quality shall conform to ASTM A1011 grades D & E.
- H. Hot-formed welded and seamless steel tubing shall conform to ASTM A500 grade B.

- I. Welded and seamless steel pipe shall conform to ASTM A53 grade B.
 - J. Stainless steel fasteners shall conform to AISI grade 304/305.
 - K. Welding electrodes are E70S used in gas metal arc process conforming to the specifications for mild steel electrodes for gas metal ARL welding AWS A518.
 - L. All exposed welds shall be cleaned of welding slag and rounded. All exposed sharp edges and corners shall be rounded.
 - M. Container shall have a hinged plastic cover with openings for screens and grit discharge and foul air ducting for odor control.
 - N. Container shall have wheels sized for the appropriate load.
- 2.3 PROTECTIVE COATING
- A. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.
- 2.4 MANUFACTURERS
- A. Manufacturer's Experience: The manufacturer must be actively engaged in the manufacture of the type of equipment specified, who can show proof and document equipment of their own design and manufacture in actual service for a period of not less than 5 years.
 - B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the equipment and for coordination of design, assembly, and testing of the equipment described in this section.
 - C. Manufacturers or Equal:
 - 1. Consolidated Fabricators
 - 2. Northeast Industrial Manufacturing

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.

END OF SECTION

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SECTION 13400
INSTRUMENT AND CONTROL SYSTEM

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. This Section gives general requirements for the instrument and control system (I&CS) which includes primary elements and transmitters, analog display and control elements, discrete display and control elements, control panels, and associated devices.

1.2 RELATED SECTION

- A. Section 13470 Programmable Controller (RTU) System
B. Section 13475 Control Strategies
C. Division 16 Electrical sections

1.3 SUBMITTALS

- A. Shop Drawings

Shop drawing submittals shall be neatly arranged in 3-ring binders which may have pockets for full-size drawings folded and CD. Tabs shall be used to separate individual items in the submittal. Loose submittals without a binder shall be rejected without review. Deviations if any from the specifications shall be summarized and tabulated on a separate document pages titled "Notes to Reviewer". Shop drawings that do not follow the required format shall be rejected without being reviewed.

1. Bill of Materials: List of required I&CS equipment.
 - a. Group equipment items by common enclosure, and equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.
 - 4) Quantity supplied.
2. Catalog Cuts: I&CS Components, Electrical Devices, and Mechanical Devices:
 - a. Catalog information.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - d. Scaled drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.
3. Component Data Sheets: Data sheets for all I&CS components.

- a. Format and Level of Detail in accordance with ISA-S20.
 - b. Specific features and configuration data for each component:
 - 1) Location or service.
 - 2) Manufacturer and complete model number.
 - 3) Size and scale range.
 - 4) Set points.
 - 5) Materials of construction.
 - 6) Options included.
 - c. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
4. Panel Construction Drawings:
- a. Scale Drawings: Show location of panel mounted devices, doors, louvers, and subpanels.
 - b. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, and wire numbering and labeling scheme.
5. Interconnection Diagrams: For discrete control and power circuits.
- a. Diagram Type: Ladder diagrams in a format similar to those shown on Drawings. Include devices requiring electrical connections. Show unique rung numbers on left side of each rung where applicable.
 - b. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MMC number), terminal strip number, and terminal block number.
 - 3) Discrete Components:
 - a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).

- b) Switching action (open or close on rising or falling process variable), set point value and units, and process variable description.
 - 4) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of rung where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
 - 5) Relay Contacts: Coil tag number, function, and coil location (ladder number and sheet number).
 - a) Show each circuit individually. No "typical" diagrams will be allowed.
 - b) Ground wires and connections.
 - c) Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 16, ELECTRICAL.
- 6. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
 - a. Loop diagrams similar to ISA format or one preferred by DISTRICT.
 - b. Conform to the minimum requirements of ISA S5.4.
 - c. Under paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs 2, 5, 6 and 9.
 - d. Drawing Size: Individual 11-inch by 17-inch sheet for three loops maximum. Loop drawings smaller than 11" x 17" will be rejected without review.
 - e. Divide each loop diagram into areas for field panel, field, terminal junction boxes, control panel and PLC.
 - f. Show:
 - 1) Terminal numbers, location of DC power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - 3) Tabular summary on each diagram:
 - a) Transmitting Instruments: Output capability.
 - b) Receiving Instruments: Input impedance.

- 4) Circuit and raceway schedule.
7. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s).
 - b. Maximum heat dissipations Btu per hour.
 - c. All calculations.
8. Termination Wiring Diagrams:
 - a. Diagrams, device designations, and symbols in accordance with NEMA ICS 250.
 - b. Show:
 - 1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
 - 2) Component and panel terminal identification numbers, and external wire and cable numbers.
 - 3) Circuit names matching Circuit and Raceway Schedules.
 - 4) Intermediate terminations between field elements and panels for, but not limited to terminal junction boxes and pull boxes.
9. Installation Details: Provide installation details and bill of materials required for the proper installation of AS Components.
10. Spares, expendables, and test equipment.
- B. Samples: Color schedule with color samples for control panels.
- C. Quality Control Submittals:
 1. Testing Related Submittals: In accordance with this Section
 2. O&M Manuals:
 - a. Refer to paragraph Shop Drawings for the following items:
 - 1) Bill of Materials.
 - 2) Catalog Cuts.
 - 3) Component Data Sheets.
 - 4) Interconnection Diagrams, one reproducible copy.
 - 5) Loop Diagrams, one reproducible copy.
 - 6) Termination Wiring Diagrams, one reproducible copy.
 - b. Device O&M manuals for I&CS components, electrical devices, and mechanical devices shall include:

- 1) Operations procedures.
- 2) Installation requirements and procedures.
- 3) Maintenance requirements and procedures.
- 4) Troubleshooting procedures.
- 5) Calibration procedures.
- 6) Internal schematic and wiring diagrams.
- 7) ORT Component and Calibration Sheets.
- 8) List of required test equipment.

c. List of spares and expendables required and recommended.

1.4 DELIVERY, STORAGE, AND HANDLING

A. In accordance with this Section

1.5 ENVIRONMENTAL REQUIREMENTS

A. Standard Environmental Requirements: Unless otherwise noted, design AS equipment for continuous operation in these environments:

1. Inside (pump station building):

- a. Temperature: 20 to 115 Deg. F.
- b. Relative humidity: 10 to 95% non- condensing.
- c. NEC classification: Non-hazardous.

2. Outside:

- a. Temperature: -32 to 120 Deg. F.
- b. Rain
- c. NEC classification: Non-hazardous except in enclosed Headworks where it is classified as Class 1 Div I hazardous location. Area at Barscreen area above ground is Class 1 Div 2 hazardous location.

B. Furnish and provide I&CS components and panels for continuous operation in its operating environments as shown and located on the Drawings. All equipment shall be suitable and designed for installation as per California Building Code regarding seismic requirements and compliance.

1.6 SEQUENCING AND SCHEDULING

A. In accordance with the DISTRICT general construction schedule.

1.7 MAINTENANCE

A. Spares Parts:

Provide the following spare parts with no additional cost to the DISTRICT. See section 13470 for additional spare parts for PLC system.

Description	Percent of Each Type and Size Used	No Less Than
Fuses	20	5
Indicating light bulbs	20	10
Relays	2	2
Terminal Blocks	10	5
Hand Switches	2	2

B. Expendables: None

1.8 WARRANTY

A. The Contractor shall provide a written warranty covering the performance, workmanship, and installation of all equipment furnished under this Section for a period of two (2) years. The Contractor shall assume responsibility for all costs incurred in achieving satisfactory performance during the warranty period. Warranties shall be in accordance with these specifications.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT AND TOOLS

Contractor shall provide the following tool to the DISTRICT for no additional cost.

Equipment	Quantity	Manufacturer and Model number
Large tool kit	1	Jensen Tools Model JTK-17LST with heavy duty case
Termination kit	1	Jensen Tools Model JTK-23B210

2.2 I&CS COMPONENTS

A. Components for Each Loop: Components for each loop shall be listed in ISA Data Sheets. Furnish all equipment that is necessary to achieve required loop performance.

2.3 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown on panel Drawing.
2. Materials: 16-gauge, Type 316, stainless steel, stamped, mounted with stainless steel screws.

3. Letters: 1/2-inch, unless otherwise noted.
- B. Component Nameplates-Panel Face: Component identification located on panel face under or near component.
1. Location and Inscription: As shown on panel Drawing.
 2. Materials: Adhesive backed, laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- C. Component Nameplates-Back of Panel: Component identification located on or near component inside of enclosure.
1. Inscription: Component tag number.
 2. Materials: Adhesive backed, laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- D. Service Legends: Component identification nameplate located on face of component.
1. Inscription: As shown on panel Drawing.
 2. Materials: Adhesive backed, laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- E. Nametags: Component identification for field devices.
1. Inscription: Component tag number.
 2. Materials: 16-gauge, 316 stainless steel.
 3. Letters: 1/4-inch imposed.
 4. Mounting: Affix to component/field instruments with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.4 PANEL FABRICATION

- A. General:
1. Panels with external dimensions and instruments arrangement as shown on Drawings except as modified in Engineer approved shop drawings.
 2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.

3. Fabricate panels, install instruments, wire, and plumb, all at the ICS subcontractor's factory.
 4. All panels shall be UL listed and shall bear UL label stating "LISTED ENCLOSED INDUSTRIAL CONTROL PANELS". (UL508). The panels shall fully conform with NEC Article 409- Industrial Control Panels.
 5. Electrical Work: In accordance with the applicable requirements of Division 16, ELECTRICAL.
- B. Temperature Control:
1. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
- C. Panel Construction:
1. Materials: Sheet steel unless otherwise shown on Drawings with minimum thickness of 10-gauge. For NEMA 4x and 3RX, 316 stainless steel shall be used.
 2. Panel Fronts:
 - a. Fabricated from a single piece of sheet steel unless otherwise shown on Drawings.
 - b. No seams or bolt heads visible when viewed from front.
 - c. Panel Cutouts: Smoothly finished with rounded edges.
 - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
 3. Internal Framework:
 - a. Provide structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
 5. Adjacent Panels: Securely bolted together so front faces are parallel.
 6. Doors:
 - a. Full height, fully gasketed access doors where shown on Drawings.
 - b. Key lockable.
 - c. Latches: Three-point, Southco Type 44 or equal.
 - d. Handles: "D" ring, foldable type.
 - e. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
 - f. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - g. Front and Side Access Doors: As shown on Drawings.

- h. Provide a latch to hold door at full open position.

D. Non-Freestanding Panel Construction:

1. Based on environmental design requirements required and referenced in Article ENVIRONMENTAL REQUIREMENTS, provide the following:
 - a. For panels located inside:
 - 1) Enclosure Type: NEMA 12.
 - 2) Materials: Steel.
 - b. For all other panels:
 - 1) Enclosure Type: NEMA 4X 316 SS.
 - 2) Materials: ABX.
2. Doors:
 - a. Oil resistant gasket sealed with continuous hinge.
 - b. Fiberglass lockable quick release latches.
3. Manufacturers:
 - a. Hoffman or equal.

F. Control Panel Electrical and control components:

Control panel shall be NEMA 4X stainless steel for outdoor installation and shall be NEMA 12 for indoor locations. Panels shall have the following features:

1. Power Distribution, motor starter within panels:
 - a. Feeder Circuits and motor starters:
 - 1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - 2) Make provisions for feeder circuit and starter conduit entry.
 - 3) Furnish terminal board for termination of wires.
 - b. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - 1) Locate to provide clear view of and access to breakers when door is open.
 - 2) Breaker sizes: Coordinate such that fault in branch circuit will blow only branch fuse but not trip the main breaker.
 - 3) Breaker and motor starter manufacturers and products:
 - a) Refer to Division 16, ELECTRICAL.

2. Signal Distribution:
 - a. Within Panels: 4 to 20 mA dc signals (may be distributed as 1 to 5V dc with a precision 250 OHM resistor).
 - b. Outside Panels: Isolated 4 to 20 mA dc only.
 - c. All signal wiring shall be twisted, shielded pairs, minimum 18 AWG.
3. Signal Switching:
 - a. Use dry circuit type relays or switches.
 - b. No interruption of 4 to 20 mA loops during switching.
 - c. Switching Transients in Associated Signal Circuit:
 - 1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
 - 2) 1 to 5V dc Signals: 0.05V, maximum.
4. Relays:
 - a. General:
 - 1) Relay Mounting: Plug-in type socket.
 - 2) Relay Enclosure: Furnish dust cover.
 - 3) Socket Type: Screw terminal interface with wiring.
 - 4) Socket Mounting: Rail.
 - 5) Provide holddown clips.
 - b. Signal Switching Relay:
 - 1) Type: Dry circuit.
 - 2) Contact Arrangement: 4 Form C contacts.
 - 3) Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
 - 4) Contact Material: Gold or silver.
 - 5) Coil Voltage: As noted or shown.
 - 6) Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - 7) Expected Mechanical Life: 10,000,000 operations.
 - 8) Expected Electrical Life at Rated Load: 100,000 operations.
 - 9) Indication Type: LED indicator lamp.
 - 10) Seal Type: Hermetically sealed case.
 - 11) Manufacturer and Product: Potter and Brumfield; Series KH/KHA, Idec equivalent, or equal.
 - c. Control Circuit Switching Relay, Nonlatching:
 - 1) Type: Compact general purpose plug-in.
 - 2) Contact Arrangement: 3 Form C contacts.
 - 3) Contact Rating: 10A at 28V dc or 240V ac.
 - 4) Contact Material: Silver cadmium oxide alloy.

- 5) Coil Voltage: As noted or shown.
- 6) Coil Power: 1.8 watts (dc), 2.7VA (ac).
- 7) Expected Mechanical Life: 10,000,000 operations.
- 8) Expected Electrical Life at Rated Load: 100,000 operations.
- 9) Indication Type: Neon or LED indicator lamp.
- 10) Push to test button.
- 11) Manufacturer and Product: Potter and Brumfield; Series KUP, Idec equivalent, or equal.

d. Control Circuit Switching Relay, Latching:

- 1) Type: Dual coil mechanical latching relay.
- 2) Contact Arrangement: 2 Form C contacts.
- 3) Contact Rating: 10A at 28V dc or 120V ac.
- 4) Contact Material: Silver cadmium oxide alloy.
- 5) Coil Voltage: As noted or shown.
- 6) Coil Power: 2.7 watts (dc), 5.3VA (ac).
- 7) Expected Mechanical Life: 500,000 operations.
- 8) Expected Electrical Life at Rated Load: 50,000 operations.
- 9) Manufacturer and Product: Potter and Brumfield; Series KB/KBP, Idec equivalent, or equal.

e. Submersible pump thermal and leak detection relays:

Refer to Section 11312G- Submersible Pumps for detailed requirements.

Relays shall be manufactured by Flygt Model CAS II, Goulds Pumps equivalent, or equal.

f. Signal conditioners:

Signal conditioners shall be manufactured by AGM Electronics, Phoenix Contact, or equal. They shall have the following characteristics:

- 1) Din rail mounted
- 2) 24VDC power input or two wire as required by design loop drawings.
- 3) 4-20mADC input with two identical 4-20mADC outputs or
- 4) Pulse input with 4-20mADC output or
- 5) 4-20mADC input with isolated 4-20mADC output

g. Intrinsically safe relays:

These relays shall be suitable for use with 24VDC power input with pilot devices such as float switches located in the classified hazardous locations as defined by NEC Article 500. Each relay shall have two double-pole double throw contacts, each rated for 5 amperes at 240V. These relays shall be manufactured by Consolidated Electric, Gem Sensors, R. Stahl, Inc, or equal.

5. Centralized Power Supplies:

- a. Furnish as required where shown on the drawings to power instruments requiring external dc power, including two-wire transmitters and dc relays.
 - b. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
 - c. Furnish redundant dc power supplies connected in such a way that DC output power is uninterrupted when one power supply is removed or is not delivering the correct output voltage.
 - d. Provide a contact closure for alarm in case of dc power supply failure.
 - e. Provide a voltmeter for each power supply.
 - f. Provide output over voltage and over current protective devices to:
 - 1) Protect instruments from damage due to power supply failure.
 - 2) Protect power supply from damage due to external failure.
 - g. Enclosures: NEMA 1.
 - h. Mount such that dissipated heat does not adversely affect other components.
Fuses: For each dc supply line to each individual two-wire transmitter.
 - 1) Type: Indicating.
 - 2) Mount so fuses can be easily seen and replaced.
 - i. Manufacturer and Products: Acopian Redundant Power Packages, Sola equivalent, or equal.
6. Standard Pushbutton Colors and Inscriptions:
- a. Use following color code and inscriptions for pushbuttons unless otherwise noted:

Tag Function	Inscription(s)	Color
OO	ON OFF	Red Green
OC	OPEN CLOSE	Red Green
OCA	OPEN CLOSE AUTO	Red Green White

Tag Function	Inscription(s)	Color
OOA	ON OFF AUTO	Red Green White
MA	MANUAL AUTO	Yellow White
SS	START STOP	Red Green
RESET	RESET	Red
EMERGENCY STOP	EMERGENCY STOP	Red
LOCAL	LOCAL	White

b. Unused or Noninscribed Buttons: Black.

c. Lettering Color:

- 1) Black on white and yellow buttons.
- 2) White on black, red and green buttons.

7. Standard Light Colors and Inscriptions:

a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Red
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

b. Lettering Color:

- 1) Black on white lenses.
- 2) White on red and green lenses.

2.5 SOURCE QUALITY CONTROL

A. Factory Demonstration Tests: Demonstrate to Engineer that I&CS panel and assemblies included in these tests for conformance to related submittals and requirements specified.

2.6 REQUIRED INSTRUMENTS FURNISHED AND INSTALLED BY CONTRACTOR

2.6.1 PRESSURE INSTRUMENTS

A. Pressure Switches and gauges:

1. General:

- a. Function: Monitor differential pressure, and provide contact closure(s) when differential pressure is at the noted set point.
- b. Type: Diaphragm actuated.

2. Performance:

- a. Set Point: As noted.
 - 1) Adjustable over the full range.
 - 2) Set as noted.
- b. Range: The noted set point shall fall between 30 and 70 percent of the range.
- c. Set Point Repeatability: Plus or minus 1/2 percent of range span.

3. Features:

- a. Diaphragm Materials: Buna-N, unless otherwise noted.
- b. Pressure Connection: Nickel-plated brass, unless otherwise noted.

4. Enclosure: NEMA 4X, unless otherwise noted.

5. Signal Interface:

- a. Contact Type: SPDT, snap action switch, rated for 5 amps at 120V ac.

6. Manufacturers:

- a. Ashcroft, B Series.
- b. United Electric, Series 300
- c. Mercoid, Series DP

B. Pressure Transmitter

1. General: Furnish and install transmitter where shown on the drawings.

- a. Measure pressure by detecting force on an integral capacitance diaphragm capsule.

2. Performance:

- a. Range: As required for process.
- b. Provide zero elevation and adjustment.

- c. Span shall be adjustable over 100 to 1 or greater range.
 - d. Adjustable damping shall be provided.
 - e. Wetted parts shall be 316SS unless otherwise specified.
 - f. Accuracy shall be $\pm 0.25\%$ of span.
 - g. Transmitter housing shall be rated explosion proof, NEMA 7.
 - h. Integral LCD meter with the transmitter housing.
 - i. HART protocol
3. Signal Interface:
- a. Transmitter output: 4-20mA current regulated to drive any load between 0-750 ohms at 24V DC.
 - b. Transmitter: Two wire type (loop powered)
4. Manufacturers:
- a. Rosemount 2051C
 - b. Foxboro, ABB
 - c. Equal

2.6.2 FLOW INDICATING TRANSMITTERS

A. Magnetic flow meters

1. General:
- a. Measure flow by flange type low frequency electromagnetic element with DC pulse signal proportional to and linear with liquid flow rate.
2. Performance:
- a. Range: See instrument index section 13482
 - b. Sensor: Minimum two bullet-nosed, self-cleaning electrodes
 - c. Meter housing hardware: NEMA 6 Submergence, epoxy painted
 - d. Sensor electrode: 316 Stainless Steel, Polyurethane liner, grounding rings
 - e. Accuracy: 0.25% of full rate
 - f. Electronic transmitter with 4-20maDC output, 3-line, 16-character LCD Display and pulse/frequency for totalization signals. NEMA 4X enclosure, 120VAC input, HART protocol,
 - g. Environment: 20 to 140 degrees F, humidity 90% non-condensing
 - h. Hand-held calibrator/programmer (shall be provided at no additional cost)
3. Manufacturers:

- a. Foxboro, ABB Magmaster, Krohne Aquaflux, Toshiba, Siemens, or equal

2.6.3 LEVEL MEASUREMENT

Furnish and install level transmitter where shown on the drawings.

A. Level transmitter (Ultrasonic type)

- 1. Continuous level measurement by soundwave
- 2. Characteristics:
 - a. Ultrasonic probe/sensor with max 30 feet length
 - b. Remote level transmitter NEMA 4X with 4-20mADC output and minimum four independent dry contacts 5A rated minimum.
 - c. Power input 120VAC
 - d. Local level indicator, keypad type with engineering unit.
 - e. HART protocol
 - f. Provided with required mounting hardware, brackets, cables.
- 3. Manufacturer:
 - a. Siemens Milltronics HydoRanger to match District standard

B. Level switches (float type)

Furnish and install float switches where shown on the drawings.

Floats shall be non-mercury switch completely sealed with water resistant, stainless steel ball with PVC outer jacket, suspended with submarine type cable. Contact shall be rated for 5 amps, 120VAC, complete with stainless steel mounting hardware such as supports. Floats shall be manufactured by Siemens Model 9G-EF, Flygt, Anchor Scientific, or equal. Intrinsically safe relay shall be provided for each float located in classified hazardous locations.

C. Level transmitter (Bubbler type)

- 1. Continuous level measurement by gauge pressure transducer with air compressor system.
- 2. Characteristics:
 - a. Ultrasonic probe/sensor with max 30 feet length

- b. NEMA 4X stainless steel panel air compressor and stainless steel tubing with gauge transducer to provide 4-20mA DC output calibrated proportional to the level.
 - c. Power input 120VAC
 - d. Local level indicator, keypad type with engineering unit.
 - e. HART protocol
 - f. Provided with required mounting hardware, brackets, cables.
3. Manufacturer:
- a. Tesco Controls,
 - b. Consolidated Electric
 - c. Equal

2.6.4. LOW RANGE TURBIDITY ANALYZER

A. Type:

- 1. Micro processor based, continuously flowing, 90 degree light scatter type turbidimeter capable of transmitting turbidity data on a network.

B. Function/Performance

- 1. Accuracy: Plus/minus 2% of reading from 0 to 10 NTU, plus/minus 5 % of reading from 10 to 40 NTU, and plus/minus 10% of reading from 40 to 100 NTU.
- 2. Repeatability: Plus/minus 1% of reading or plus/minus 0.002 NTU, whichever is greater.
- 3. Resolution: 0.0001 NTU up to 9.9999 NTU, and 0.001 NTU from 10.000 to 99.999 NTU.
- 4. Range: 0.001 to 100 NTU.
- 5. Environmental Conditions: 0 to 40 °C and 5 to 95 percent relative humidity, non-condensing.
- 6. Output: Two 4-20 mA outputs adjustable over the full instrument range, and at least 2 SPDT alarm contacts rated 5A at 230 VAC, which can be adjusted to trip at any point in the instrument range.
- 7. Display: Digital indicator displaying turbidity in NTUs.

C. Physical

- 1. Suitable for wall or floor stand mounting.
- 2. Where required, a DC power supply shall be provided with each turbidimeter. A/C power will be as specified in Section 13400.
- 3. NEMA 4X (IP66) enclosures.

D. Accessories Required

- 1. A factory calibrated optical device for verification of calibration without the use of consumables.

2. One year supply of consumables for calibration and a calibration kit that includes adapters and components necessary to perform instrument calibration.
3. All cables, connectors, and tubing required for a fully operational turbidimeter.

E. Manufacturer(s)

1. Hach Model 1720E.
2. SWAN Analytical Instruments Model Monitor AMI Turbiwell W/LED.
3. Approved equal.

PART 3 EXECUTION

3.1 GENERAL

- A. Floor plan layout for I&CS components are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
- B. Coordinate Work with Division 11, EQUIPMENT and Division 15, MECHANICAL.
- C. Wiring: Refer to this Section and Division 16, ELECTRICAL.

3.2 FIELD QUALITY CONTROL:

- A. Perform functional tests to assure all devices are functional individually prior to system testing.
- B. Perform final acceptance testing at the presence of the DISTRICT's representative, the Engineer.

3.3 TRAINING

- A. Operation: For DISTRICT's operations personnel on operation of I&CS.
 1. Training Session Duration: 1 instructor day.
 2. Number of Training Sessions: 2
 3. Location: Project site.
 4. Content: Conduct training on loop-by-loop basis.
 - a. Loop Functions: Understanding of loop functions including interlocks for each loop.
 - b. Loop Operation: For example, adjusting process variable set points, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - c. Interfaces with ICS Subsystems.

B. Maintenance Training:

1. Training Session Duration: 1 instructor day.
2. Number of Training Sessions: 2
3. Location: Project site.
4. Content: Provide training for each type of component and function provided.
 - a. Loop Functions: Understanding details of each loop and how they function.
 - b. Component calibration.
 - c. Adjustments: For example, device setup parameters, controller tuning constants, current switch trip points, and similar items.
 - d. Troubleshooting and diagnosis for and components.
 - e. Replacing lamps, chart paper, fuses.
 - f. AS components removal and replacement.
 - g. Periodic maintenance.

END OF SECTION

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SECTION 13470
SCADA - PROGRAMMABLE LOGIC CONTROLLER SYSTEM

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. General:

- a. The Contractor shall furnish, install and wire all SCADA system hardware required for this project. The SCADA system control panel shall be manufactured by Calcon Systems Inc to match existing system installation. However, the PLC and local HMI software programming requirements provided in the Contract Documents is for reference purposes only as it will be provided and performed by a third party (Calcon) hired by the District. The Contractor however shall be required to provide all labor and materials to wire and connect all new signals to the new PLC systems as specified and as shown on the drawings. Final terminations of signals shall be done by Calcon.
- b. For area where existing PLC to be added with new cards and new points, the existing PLC cabinet shall remain functional during construction, and shall remain after successful addition of new signals.

2. Control System Responsibilities:

- a. The Contractor shall be responsible for all control systems work described in these specifications and drawings, including PLCs, network/communication equipment, except for programming and configuration services explicitly specified to be provided by the District. The Contractor shall be responsible for all submittals, purchasing, assembly, packing, shipping, installation, set up, startup, specified testing, and as-built drawings for all control system equipment and purchase new hardware and auxiliaries.
- b. The Contractor or subcontractor shall test the PLC/I/O system as specified herein to verify proper performance independent of the use of the PLC software provided by the District.
- c. The Contractor shall provide the communications network as specified herein and indicated on the Drawings and other sections of the specification.
- d. Perform testing and training as described in this section.

3. Definitions:

- a. Where a term is used in this section relating to instrumentation, and the meaning is not defined therein or elsewhere in the Contract Documents, the meaning of the term shall be as defined in ISA S51.1 Process Instrumentation Terminology, or if not contained in ISA 51.1, as defined in listed reference standards under "References".
- b. CEET - Complete End to End Testing.

- c. Control Circuit: Any logical circuit (operating usually at 120VAC or less or DC) whose principal purpose is the conveyance of control and interlock/protection information and not the conveyance of energy for the operation of an electrically powered device.
- d. HMI: Human Machine Interface.
- e. LAN: Local Area Network e.g. Ethernet is a local area network based on IEEE standard 802.3 with TCP/IP protocol.
- f. NAT - Network Acceptance Testing.
- g. Panel: An instrument support system which may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term "panel" in these Contract Documents shall be interpreted as a general term, which includes flat panels, enclosures, cabinets and consoles.
- h. PLC: Programmable Logic Controller.
- i. Power Circuit: Any circuit operating at 120 VAC or more, whose principal purpose is the conveyance of power for motors, lighting and other power devices.

B. Test:

1. General:

- a. Any testing or startup activity that requires the participation of the District shall be scheduled by the Contractor through written notification to the District. Contractor shall provide regularly updated testing and startup schedules to the District. In addition to any other form of notification, Contractor shall notify the District by email, or other mutually agreed upon means, five working days immediately prior to any testing or other activity requiring the participation of the District. Failure to properly notify District shall result in rescheduling of test activity, solely at Contractor expense and without an extension to the project completion schedule.

2. Operational Readiness Tests (ORT):

- a. General: Prior to startup and the Functional Acceptance Test, the entire system shall be certified (inspected, tested and documented) that it is ready for operation.
- b. Basic End-to-End Testing (BEET):
 - i. For each and every analog and discrete circuit, perform Basic End-to-End Testing (BEET). This includes, but is not limited to, all local control panels, MCCs, VFDs, and hardwired circuits in control panels.
 - ii. For each input, activate the signal at the primary field device, either by creating necessary process and equipment conditions or by disconnecting the wires at the field device and simulating the input signal. At the PLC, using the PLC programming software, verify proper receipt of the signal.
 - iii. For each output signal from the PLC, activate the PLC output signal using the PLC programming software, and verify proper receipt of the signal at the controlled device in the field, either by observing equipment operation or

by disconnecting the wires at the equipment and verifying proper receipt of the signal.

- iv. Verify proper signal receipt at all intermediate devices, such as indicators, signal trip and relay modules, etc.
- v. The Loop/Component Inspections and Tests shall be implemented using District-approved forms and checklists.
- vi. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment and calibration. These reports shall include the following information and check off items with spaces for sign off by the system supplier:
 - a). Project Name.
 - b). Loop Number.
 - c). Tag Number for each component.
 - d). Check offs/signoffs for each component.
 - e). Tag/identification.
 - f). Installation.
 - g). Termination - wiring.
 - h). Termination - tubing.
 - i). Calibration/adjustment.
 - j). Signoffs/signoffs for the loop.
 - k). Panel interface terminations.
 - l). I/O interface terminations.
 - m). I/O signal operation.
 - n). Inputs/outputs operational: received/sent, processed, adjusted.
 - o). Total loop operation.
 - p). Space for comments.
 - q). Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry and a space for sign off by the system supplier:
 - 1). Project Name.
 - 2). Loop Number.
 - 3). Component Tag Number of I/O Module Number.
 - 4). Component Code Number Analog System.
 - 5). Manufacturer (for Analog system element).
 - 6). Model Number/Serial Number (for Analog system).
 - 7). Summary of Functional Requirements. For example:

- (a). For Indicators and Recorders: Scale and chart ranges
 - (b). For Transmitters/Converters: Scale and chart ranges
 - (c). For Computing Elements: Function
 - (d). For Controllers: Action (direct/reverse) control modes (PID)
 - (e). For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
 - (f). For I/O Modules: Input or output
- r). Calibrations; for example:
 - 1). For Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75 and 100 percent of span, rising and falling.
 - 2). For Discrete Devices: Required and actual trip points and reset points.
 - 3). For Controllers: Mode settings (PID).
 - 4). For I/O Modules: Required and actual inputs or outputs for 0, 10, 25, 50, 75 and 100 percent of span, rising and falling; 9 points calibration (5 points calibration will be rejected).
 - 5). Space for comments.
 - 6). Space for sign off by the ISS.
 - 7). The ISS shall maintain the Loop Status Reports and Components Calibration sheets at the job site and make them available to the Construction Administrator/District at any time.
- s). These inspections and tests do not require witnessing. However, the Construction Administrator 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.
- c. Complete End-to-End Acceptance Tests (CEET):
 - i. For each PLC, CEET testing shall not commence until all Loop Acceptance Tests for the PLC have been satisfactorily completed, and all test results (including all forms signed off) have been submitted for review and accepted. For each and every analog and discrete circuit, perform an end-to-end test between the field device and the HMI computer operator station, and including all intermediate readouts. Also test each signal circuit transmitted over digital networks (i.e. ETHERNET, RS-422 links, etc.).
 - ii. In general, the end-to-end testing is a two or more person test. The Contractor shall provide personnel to operate equipment or simulate signals that are to be verified as part of this test.
 - iii. Check each loop from the field element to the respective computer control display. Include all intermediate field instruments, control devices, panels, indicators and other devices in the loop to ensure proper operation and linkage to computer control station displays.

- iv. Analog signals shall be tested at 0, 50, and 100 percent of scale to verify the proper receipt on computer control displays.
- v. Discrete input circuits shall be tested to verify proper state when the field device is switched between states. Discrete output circuits shall be tested to verify equipment responds properly (start, stop, etc.).
- vi. Contractor shall provide adequate time in the Construction Schedule for CEET testing.

3. FUNCTIONAL ACCEPTANCE TEST (FAT)

- a. Prior to startup and the Functional Acceptance Test (FAT), the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Tests.
- b. Once the facility has been started up and is operating, a witnessed FAT shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
- c. Strategy Field Testing (SFT):
 - i. This test shall be performed by the Integrator with the assistance and cooperation of the Contractor. The Contractor shall provide a qualified start-up and testing representative on-site, assisting and participating in the testing full-time, for the duration of the SFT.
 - ii. The Contractor shall include in the Construction Schedule at least two days of SFT testing work for each of the control strategies and shall provide staff for these periods, as required above for this work.
 - iii. For each control strategy and for each electrical schematic diagram, demonstrate the proper operation of all hardware and software logic and control functions. Perform a step by step test of each function described in each control strategy.
 - iv. Perform separate tests on each individual piece of equipment, and for each control loop.
 - v. Perform the proper operation of each discrete control loop to ensure the proper operation of motors, hand switches, interlocks, solenoid valves, other auxiliary devices, status lights, computer control operator interfaces, and alarms.
 - vi. Updated versions of the documentation specified to be provided for during the Factory Tests shall be made available at the job site both before and during the tests. In addition, one copy of all O&M Manuals shall be made available at the job site both before and during testing.
 - vii. The system shall operate for a continuous 96 hours without failure before this test will be considered successful.

1.2 QUALITY ASSURANCE

A. References:

1. Work specified in this Section shall follow the applicable code and standards: EIA, ANSI, IEEE, ISA and NFPA.
2. Where provisions of the pertinent codes and regulations, requirements of the referenced standards, or these specifications conflict, the more stringent of the requirements shall govern.

1.3 SUBMITTALS

A. General:

1. Make all submittals and resubmittals in strict accordance with the provisions of Division 1, Section 1A-7 - Submittals, Manuals, Operating Instructions, and Affidavits.
2. Make all submittals listed in Part 1.03-B, and any others required to fully describe what is to be furnished and/or installed under this Section.

B. Required Submittals:

1. Drawing index.
2. System configuration diagram.
3. Hardware list and cutsheets.
4. Test plan.

PART 2 – PRODUCTS

2.1 MANUFACTURER AND SUPPLIER

- A. The existing PLC are manufactured by AutomationDirect DL4 Series as the District SCADA Standards. The new PLC shall be from same manufacturer to match existing standard. For existing PLC where modifications are required, new components shall be manufactured by same. No other manufacturers are acceptable. New I/O hardware/cards are required including communication module for connections to the required signals. Contractor shall provide complete wiring from the field to the PLC I/O cards' terminals as detailed on the drawings. The Contractor shall obtain the PLC Control Panel components from Calcon System Inc (925) 277-0665 as shown on the Drawings and as specified in this section:
- B. Provide and install the PLC system hardware for the SCADA system as shown on the following drawings:
 1. E-12, E-13, E-14, E-15, E-16, E-28, E-33, E-34 and I-3
- C. Furnish loose spare parts for no additional costs to the District:
 1. One 8-point Analog Input card model no.F2-08AD-1
 2. One 8-point Analog Output card model no.FF2-08DA-1

3. Two 16-point Digital Input cards model no.D2-16ND3-2

- D. Model number of each component in the PLC System shall be as required per the latest Standards Established by Calcon and the District.

PART 3 – EXECUTION

3.1 ACCEPTANCE TESTING

- A. Perform final acceptance testing with the presence of the District and the District's representative. Demonstrate all correct signal wirings and control logics to the District's satisfaction. (The District will furnish PLC/HMI software performed by Calcon under separate contract). Retest shall be performed at no cost to the District if the first test is not satisfactory.

3.2 TRAINING

- A. Provide two 2-hour training sessions for 2 plant personnel at the site. The training shall include classroom and hands-on practice of the system furnished.
- B. Perform factory tests in the District's presence. Notify the District one week prior to actual scheduled factory test. See Part 1 for additional requirements.

3.3 PLC/HMI SOFTWARE TESTING ASSISTANCE

- A. The PLC/HMI application software is provided by a third party (Calcon) hired by the District. However, the Contractor shall provide assistance to this third party when they perform software testing in the field during final pump station startup operations. Provide field staff for at least two weeks to assist this effort. See Part 1 for additional requirements.

3.4 CONTROL STRATEGIES

SEE SECTION 13475 FOR REFERENCES

END OF SECTION

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SECTION 13475 CONTROL STRATEGIES

PART 1 GENERAL

1.1 DESCRIPTION

A. WORK SCOPE

This Section specifies requirements regarding software configuration for programmable logic controller (PLC) (In this project, the term “Remote Terminal Unit” (RTU) is interchangeable with PLC), Local HMI display and SCADA System. All these software programming and configuration in this project shall be performed by third party hired by the District, and shall be Calcon who has been the designated system integrator by the District.

1.2 RELATED SECTIONS

- A. Section 13400 – Instrument and Control Systems.
- B. Section 13470 – Programmable Logic Controller (RTU) System.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

This existing main sewage plant has been designed and operational with a programmable logic controller (PLC) based control system which primarily provides the control and monitoring functions of the pumping equipment and associated facility auxiliary equipment. In general, the PLC will have control logic to execute the required control functions based on process parameters such as level in the wet well. Exact system process parameter set points shall be as determined and directed by the District during final start up. In addition, the control system shall be programmed to provide all alarm and monitoring functions such as equipment run, fail, overload, open, close, process parameter values (low low, high high) , and software generated failure-to-start, failure-to-open, failure-to-close. Each alarm and monitoring functions of each equipment shall be duplicated at HMI and SCADA communication network.

In addition to the functions described in the later loop specifications, at each programmed layer, provide the following general functions as they apply to the signals available to that layer.

1. Monitor and Display Discrete Inputs. Receive inputs, display, and alarm where applicable. Provide alarm logging.

2. Display and Allow Tuning of Set Points. Display set points, allow them to be changed, and where password protection functions are available, implement them to restrict access to set points.
3. Monitor and Display Analog and Pulse-Frequency Inputs. Received inputs, and display. Provide configurable low and high alarm set points for each signal. Trench each input for a configuration interval, in a first-in first-out arrangement. Provide resettable and non-resettable flow, run time and power consumption totalizers for each applicable input.
4. Elapsed Time. Provide resettable and nonresettable elapsed time integrators for pump runtime. For the resettable variable, provide a configurable set point unique to each pump at which an alarm will occur, triggering the need for service.
5. Loss of Input. Hold the last known value, alarm.
6. Attempt to Command Only Controllable Equipment. Monitor equipment status where available (such as LOCAL/REMOTE selection), and attempt to control equipment which is available to the PLC and which has not failed.
7. Pump Fail to Start/Fail to Stop. Upon issuance of an START or STOP command, if within a configuration interval the pump does not reach the command position, an alarm shall be issued. Provide a configurable interval on a pump-by-pump basis. Lock out the gate until a RESET command is issued.
8. Equipment Fail. On receipt of a FAIL or similar discrete input, or when the item of equipment fails to attain the commanded state within a configurable interval, an alarm shall be issued. Provide a configurable interval for each item of equipment. Lock out the item of equipment until a RESET command is issued.
9. Loss of Communication. Alarm on loss of communications from SCADA HMI host to site PLCs or/and from site PLCs to SCADA.

3.2 CONTROL STRATEGIES

CS-100**INFLUENT SCREENING****A. References:**

Drawings: I100-1, I100-2

PLC: PLC-HW and LCPs (manufacturer provided).

B. Summary Description:

There are two automatic spiral screens and one manual screen. Each automatic screen is controlled by a manufacturer supplied local control panel and PLC. The manufacturer LCP will control the screen operation, receive remote commands and generate status and alarm signals. In automatic mode, the screens will operate based on headloss across the screen or based on preset time intervals. Screenings removed by the screens will be discharged into the shaftless screw conveyor, which will transport the material to a combined screenings and grit dumpster.

C. Field Controls and Instrumentations:**1. Instrumentation**

- a. Ultrasonic (upstream of screen 1): SC-EQP1-LIT-01
- b. Ultrasonic (upstream of screen 2): SC-EQP2-LIT-01

2. Local Control Devices

- a. Screens
 - 1.) Manufacturer supplied LCP - Refer to packaged equipment I/O list for virtual point.
 - 2.) Need to confirm if separate E-STOP button is desired close to screens. E-STOP for the screens will be included on the LCP.
- b. Shaftless Screw Conveyor
 - 1.) Manufacturer supplied LCP with ON-OFF-REMOTE switch
 - 2.) E-STOP pushbutton
 - 3.) E-STOP pull cord located on the shaftless screw conveyor

3. Hardwired Interlocks

- a. As required per manufacturer.

4. Local Process Indicators and Alarms

- a. Screens
 - 1.) Refer to packaged equipment I/O list for virtual point.
- b. Shaftless Screw Conveyor
 - 1.) NO/SLOW SPEED

2.) E-STOP activated

5. MCC Status/Control Functions:

- a. None

D. PLC/SCADA Monitoring and Control Functions

- a. Screens
 - 1.) Refer to packaged equipment I/O list for virtual point
 - 2.) Screen ON
 - 3.) Screen RUNNING (monitoring)
 - 4.) E-STOP (monitoring)
- b. Shaftless Screw Conveyor
 - 1.) ON/OFF-AUTO
 - 2.) AUTO mode selectable based on time or screen operation
 - 3.) TROUBLE
 - 4.) E-STOP (monitoring)

1. Control (Manufacturer LCP)

A. Automatic Mode:

1. Screen - Brush

When the screen selector is in the AUTO position the screen will begin to run due to any of the following conditions:

- i. Level rises (SC-EQP1-LIT-01) and remains above the start level setpoint for the time set in the level start delay timer.
- ii. Screen has remained off for the time set in the screen off timer
- iii. System reset pushbutton pressed and held for 3 seconds

Once the screen starts it will run continuously in the forward direction until the level drops below the start level setpoint, per the time setting in the screen off delay timer.

Screen cleaning cycle: A screen cleaning cycle will be initiated after the screen has run for the time set in the screen accumulated run timer. The screen will stop, dwell, run reverse for the time set in the screen cleaning reverse run time, stop, dwell and continue forward if a call to run is still present.

2. Screen - Press Zone Spray Wash

When the press zone wash selector is in the AUTO position, the press zone wash will cycle on and off, on time first, per repeat cycle times set in the plc, independent of the screen operation.

3. Screen - Wash Water

When the wash selector is in the AUTO position, the wash will cycle on and off, on time first, per repeat cycle times set in the plc, any time the screen is operating in the forward direction.

4. Shaftless Screw Conveyor

When the SCADA AUTO mode is selected (and local control is in REMOTE), the conveyor shall have the following operator selectable modes of operation:

- i. Time: ON for 2 minutes, every 20 minutes.
- ii. Move in conjunction with screen operation: ON for 5 minutes each time a screen cycles through operation.

B. Manual Mode:

1. Screen - Brush

When the screen selector is in the HAND position, the screen will cycle on and off with the screen FOR-OFF-REV selector.

- i. FOR: When the screen selector is in the HAND position, and the forward direction is selected, the screen will run continuously in the forward direction.
- ii. REV: when the screen selector is in the HAND position and the reverse direction selected, the screen will run continuously in the reverse direction. This switch will spring return from REV to OFF.

2. Screen - Press Zone Spray Wash

When the press zone wash selector is in the HAND position, the press zone wash will run continuously.

3. Screen - Wash Water

When the wash selector is in the HAND position, the wash will run continuously.

4. Screen - Emergency Stop

When any of the E-STOP pushbuttons are pressed the screen and spray washes will stop immediately, the control power on light will de-energize. To reset, ensure all e-stops are enabled, and press the system reset pushbutton.

5. Shaftless Screw Conveyor

- i. ON: When the hand selector switch is in the ON position, the conveyor will run continuously.

- ii. E-STOP: When any of the E-STOP pushbuttons are pressed the shaft less screw conveyor will stop immediately, the control power on light will de-energize. To reset, ensure all e-stops are enabled, and press the system reset pushbutton.
- 2. The SCADA screen(s) shall display the following variables and status:
 - a. For each screen:
 - 1. Level in front of screen
 - 2. RUN
 - 3. FAIL
 - 4. High Level alarm
 - b. Shaftless Screw Conveyor
 - 1. RUN
 - 2. No/Slow Speed Alarm
 - 3. E-STOP activated
 - c. All signals listed in the packaged equipment I/O list
- 3. Software Interlocks: NONE
- 4. Trend Variables:
 - a. Level in front of screen
 - b. Screen RUN time
 - c. Screen starts per hour
 - d. Screw conveyor starts per hour
- 5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
 - a. Manual Start/Stop: Yes
 - b. Manual Speed Control: No
 - c. Manual/PLC Selection: No

CS-120**GRIT REMOVAL****A. References:**

Drawings: I100-1, I100-3
PLC: PLC-HW and LCP (manufacturer provided).

B. Summary Description:

The grit removal consists of a hydraulic vortex grit unit, two grit pumps and a single grit washer. The hydraulic vortex grit unit does not require any signals or control for operation. The grit pumps will operate in a duty/backup arrangement. The grit washer is controlled by a manufacturer supplied local control panel GC-EQP1-LCP-01 and PLC. The manufacturer LCP will control the screen operation, receive remote commands and generate status and alarm signals. In automatic mode, the grit unit will operate based on an ON signal from the grit pumps or an RUN signal from SCADA. Grit cleaned by the grit washer will be discharged into a combined screenings and grit dumpster.

C. Field Controls and Instrumentations:**1. Instrumentation**

- a. Grit Pump 1 discharge check valve position switch: GRT-PMP1-ZSL-01
- b. Grit Pump 2 discharge check valve position switch: GRT-PMP2-ZSL-01

2. Local Control Devices

- 1. Manufacturer supplied LCP - Refer to packaged equipment I/O list
- 2. Need to confirm if separate E-STOP button is desired close to grit washer
- 3. E-STOP will be included on the LCP.

3. Hardwired Interlocks

- a. As required per manufacturer.
- b. The stirrer, grit screw, organics valve, and wash water selector switches must all be in the AUTO position for the grit washer to function in the auto mode.
- c. If the stirrer, grit screw, or organics valve are faulted, the stirrer, grit screw, organics valve, and wash water will not function in the auto mode.

4. Local Process Indicators and Alarms

- a. Refer to packaged equipment I/O list

5. MCC Status/Control Functions:

- a. Grit Pump 1: START/STOP, HAND-OFF-AUTO
- b. Grit Pump 2: START/STOP, HAND-OFF-AUTO

- c. Hi pressure Alarm (Grit Pump 1)
- d. Hi pressure Alarm (Grit Pump 2)
- e. Grit pump overloads.

D. PLC/SCADA Monitoring and Control Functions

- a. See packaged equipment I/O list for virtual point
- b. Grit Washer E-STOP activated
- c. Grit Pump 1: RUN, FAIL and high pressure alarm
- d. Grit Pump 2: RUN, FAIL and high pressure alarm

1. Control

A. Automatic Mode:

1. Grit Pumps

When the grit pumps are in the AUTO position and the SCADA selector is in the AUTO position the grit pumps will run in a duty standby mode in one of two operational modes:

- i. Intermittent Operation: Grit pump will operate based on timer set at a tunable time period of 5 minutes ON at a tunable frequency of every 15 minutes. Duty pump will be alternated every start.
- ii. Continuous Operation: Duty grit pump will operate continuously.

2. Grit Washer

When the grit washer selector is in the AUTO position the grit wash will begin to run due to any of the following conditions:

- i. An ON command has been received from SCADA. Once the ON signal is removed the grit washer will run a shutdown cycle.
- ii. When a grit pump is running. Once the grit pump running signal is removed the grit washer will run a shutdown cycle.

B. Manual Mode:

1. Grit Pumps

Grit pumps will operate manually according to the HOA switch selected in Hand mode.

2. Grit Washer

As recommended by the manufacturer for manual operational modes for individual components.

3. Emergency Stop

When any of the e-stop pushbuttons are activated the grit washer will stop immediately, the control power will de-energize. To reset, ensure all e-stops are enabled, and press the system reset pushbutton or use keypad.

2. The SCADA screen(s) shall display the following variables and status for each piece of equipment:
 - a. See packaged equipment I/O list
 - b. Grit Washer RUN, FAIL, in AUTO
 - c. Grit Washer E-STOP activated
 - d. Grit Pump 1 RUN, FAIL and High Pressure Alarm
 - e. Grit Pump 2 RUN, FAIL and High Pressure Alarm
3. Software Interlocks: Grit pumps shall shut down if a grit washer alarm is received.
4. Trend Variables:
 - a. Grit washer RUN time
 - b. Grit washer starts per hour
 - c. Grit pump RUN time
 - d. Grit pump starts per hour
5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
 - a. Manual Start/Stop: Yes
 - b. Manual Speed Control: No
 - c. Manual/PLC Selection: No

A. References:

Drawings: I100-1, I100-4
PLC: PLC-HW in Headworks MCC room.

B. Summary Description:

Equalization (EQ) storage and pumping consists of Equalization Storage Basin No. 1 and No. 2 and two self priming EQ return pumps. Each pump has a nominal capacity of about 2 MGD at full speed. The pumps are identical and both pumps will be driven by VFDs.

The purpose of the EQ basins is to even out flows to the secondary treatment process during dry weather and limit flows to the secondary treatment process to less than 9 MGD during peak wet weather flow events. The total capacity of the two EQ basins is 600,000 gallons with approximately 435,000 gallons of capacity in EQ Basin 1 and 165,000 gallons of capacity in EQ Basin 2.

In dry weather operation the EQ basins will store primary effluent to attenuate diurnal flow. In wet weather operation the EQ basins may store primary effluent, or primary influent. Raw influent can also be stored in the EQ basins, if necessary for maintenance. If one EQ basin is full, flows will passively overflow via an overflow weir between the two basins.

C. Field Controls and Instrumentations:

1. Instrumentation

- a. EQ Pump Flow Meter: EQ-PVLV10-FIT-01
- b. Primary Influent Channel Level Element/Transmitter: HW-FLW1-LE-02/HW-FLW1-LIT-02
- c. EQ Basin No. 1 - Level Element/Transmitter: EQ1-LE-01/EQ1-LIT-01
- d. EQ Basin No. 2 - Level Element/Transmitter: EQ2-LE-01/EQ2-LIT-01
- e. EQ Basin No. 1 - High-High Level Float Switch: EQ1-LSHH-01
- f. EQ Basin No. 2 - High-High Level Float Switch: EQ2-LSHH-01
- g. EQ Pump No. 1 – Discharge Pressure Indicator/Transmitter/High Switch: EQ-PMP1-PE-01/EQ-PMP1-PIT-01/EQ-PMP1-PSH-01
- h. EQ Pump No. 2 - Discharge Pressure Indicator/Transmitter/High Switch: EQ-PMP2-PE-01/EQ-PMP2-PIT-01/EQ-PMP2-PSH-01
- i. EQ Pump No. 1- Suction Pressure Indicator/Low Switch: EQ-PMP1-PI-01/EQ-PMP1-PSL-01
- j. EQ Pump No. 2- Suction Pressure Indicator/Low Switch: EQ-PMP2-PI-01/EQ-PMP2-PSL-01
- k. EQ Pump No. 1 – Primary Effluent Plug Valve Position Switch: EQ-PMP1-PVLV10-01- ZSH-02/EQ-PMP1- PVLV10-01- ZSL-02

- l. EQ Pump No. 2 – Primary Effluent Plug Valve Position Switch: EQ-PMP2-PVLV10-01- ZSH-02/EQ-PMP2- PVLV10-01- ZSL-02
- m. EQ Pump No.1 – EQ Suction Plug Valve Position Switch: EQ-PMP1-PVLV10-02- ZSH-01/EQ-PMP1- PVLV10-02- ZSL-01
- n. EQ Pump No. 2 – EQ Suction Plug Valve Position Switch: EQ-PMP2-PVLV10-01- ZSH-01/EQ-PMP2- PVLV10-01- ZSL-01
- o. EQ Primary Influent Modulating Weir Gate (EQ-GAT3) Position Indicator: EQ-GAT3-ZIT-01
- p. EQ Basin No.1 Gate (EQ-GAT1) Position Switch: EQ-GAT1-ZS-01
- q. EQ Basin No. 2 Gate (EQ-GAT2) Position Switch: EQ-GAT2-ZS-01
- r. EQ Pump Discharge – Headworks Return Plug Valve Position Indicator (EQ-PVLV10-05): EQ- PVLV10-05-ZSH-02/EQ- PVLV10-05-ZSL-02
- s. EQ Pump Discharge – Primary Effluent Return Plug Valve Position Indicator (EQ-PVLV10-04): EQ-PVLV10-04-ZSH-01/EQ-PVLV10-04-ZSL-01
- t. EQ Basin No. 1 Solenoid Valve: EQ1-TRS1-SVLV02-01
- u. EQ Basin No. 2 Solenoid Valve: EQ2-TRS1-SVLV02-01
- v. EQ Basin No. 2 Solenoid Valve: EQ2-TRS2-SVLV01-01
- w. EQ Basin No. 1 Sump Solenoid Valve: EQ1-SVLV01-01
- x. EQ Basin No. 2 Sump Solenoid Valve: EQ2-SVLV01-01
- y. EQ Primary Effluent Gate 5 position switch: EQ-GAT5-ZS-01
- z. EQ Primary Effluent Return Gate 4 position switch: EQ-GAT4-ZS-01

2. Local Control Devices:

- a. Equalization Pump No. 1 – START/STOP, HAND-OFF-AUTO with speed increase/decrease pushbuttons
- b. Equalization Pump No. 2 – START/STOP, HAND-OFF-AUTO with speed increase/decrease pushbuttons
- c. EQ Pump No. 1 EQ Suction Plug Valve, EQ-PMP1-PVLV10-01 (motorized)
- d. EQ Pump No. 1 PE Suction Plug Valve, EQ-PMP1-PVLV10-02 (motorized)
- e. EQ Pump No. 1 Discharge Plug Valve, EQ-PMP1-PVLV10-03(motorized)
- f. EQ Pump No. 2 EQ Suction Plug Valve, EQ-PMP2-PVLV10-01 (motorized)
- g. EQ Pump No. 2 PE Suction Plug Valve, EQ-PMP2-PVLV10-02 (motorized)
- h. EQ Pump No. 2 Discharge Plug Valve, EQ-PMP2-PVLV10-03 (motorized)
- i. Headworks Return Plug Valve, EQ-PVLV10-05 (motorized)
- j. Primary Effluent Return Plug Valve, EQ-PVLV10-04 (motorized)
- k. EQ Primary Influent Modulating Weir Gate (EQ-GAT3)
- l. All motorized valves and gates will have backup manual actuators.

3. Hardwired Interlocks: None

4. Local Process Indicators and Alarms at LCS:

- a. EQ Basin No. 1 Level (EQ1-LIT-01)
- b. EQ Basin No. 2 Level (EQ2-LIT-01)
- c. EQ Basin No 1. Low Level Alarm (from Analog signal)
- d. EQ Basin No 2. Low Level Alarm (from Analog signal)
- e. EQ Basin No 1. High High Alarm (EQ1-LSHH-01)

- f. EQ Basin No 2. High High Alarm (EQ2-LSHH-01)
 - g. EQ Return Pump Flow (instantaneous) (EQ-PVLV10-FIT-01)
- 5. MCC Status/Control Functions:
 - a. RUN, FAIL, Hi pressure, Low Pressure Alarm
- D. PLC/SCADA Monitoring and Control Functions (incl. HMI in Electrical Room)
 - a. Equalization Pump No. 1 – START/STOP with manual speed or automatic control selector
 - b. Equalization Pump No. 2 – START/STOP with manual speed or automatic control selector
 - c. EQ Return Pump Flow
 - d. Equalization Pump Station Mode Selector (When in Automatic): DRY WEATHER PRIMARY EFFLUENT, WET WEATHER PRIMARY EFFLUENT , WET WEATHER PRIMARY INFLUENT
 - e. EQ Basin No. 1 Low Level Alarm
 - f. EQ Basin No. 1 Low-Low Level Alarm
 - g. EQ Basin No. 2 Low Level Alarm
 - h. EQ Basin No. 2 Low-Low Level Alarm
 - i. EQ Basin No. 1 High Level Alarm
 - j. EQ Basin No. 1 High-High Level Alarm
 - k. EQ Basin No. 1 High Level Alarm
 - l. EQ Basin No. 1 High-High Level Alarm
 - m. EQ Pump No. 1 – Discharge Pressure Indicator
 - n. EQ Pump No. 2 - Discharge Pressure Indicator
 - o. EQ Pump No. 1 – Discharge High Pressure
 - p. EQ Pump No. 2 - Discharge High Pressure
 - q. EQ Pump No. 1- Suction Low Pressure
 - r. EQ Pump No. 2- Suction Low Pressure
 - s. EQ Primary Influent Modulating Weir Gate (HW-GAT5) – Level (Position)
 - t. EQ Primary Influent Modulating Gate (EQ-GAT3) – UP
 - u. EQ Primary Influent Modulating Gate (EQ-GAT3) – DOWN
 - v. EQ Basin No.1 Gate (EQ-GAT1) – Position
 - w. EQ Basin No. 2 Gate (EQ-GAT2) – Position
 - x. EQ Pump No. 1 EQ Suction Plug Valve (EQ-PMP1-PVLV10-01) – Position indicator/Open/Close
 - y. EQ Pump No. 1 PE Suction Plug Valve (EQ-PMP1-PVLV10-02) – Position indicator/Open/Close
 - z. EQ Pump No. 1 Discharge Plug Valve (EQ-PMP1-PVLV10-03) – Position indicator/Open/Close
 - aa. EQ Pump No. 2 EQ Suction Plug Valve (EQ-PMP2-PVLV10-01) – Position indicator/Open/Close
 - bb. EQ Pump No. 2 PE Suction Plug Valve (EQ-PMP2-PVLV10-02) – Position indicator/Open/Close
 - cc. EQ Pump No. 2 Discharge Plug Valve (EQ-PMP2-PVLV10-03) – Position indicator/Open/Close

- dd. Headworks Return Plug Valve (EQ-PVLV10-05) – Position indicator/Open/Close
- ee. Primary Effluent Return Plug Valve (EQ-PVLV10-04) – Position indicator/Open/Close
- ff. EQ Wet Well Solenoid Valves (EQ1-TRS1-SVLV02-01, EQ2-TRS1-SVLV02-01, EQ2-TRS2-SVLV02-01, EQ1-SVLV01-01, EQ2-SVLV01-01) – OPEN-CLOSE
- gg. Secondary Influent Flow (Calculated, formula dependent on valve EQ Return Pump operation)
- hh. EQ Primary Effluent Gate 5 position indicator – OPEN/CLOSE
- ii. EQ Primary Effluent Return Gate 4 position indicator – OPEN/CLOSE

1. Control

A. Automatic Mode:

1. Equalization Pumps

When the equalization pumps are in the AUTO position and the SCADA selector is in the AUTO position, the equalization pumps will operate as duty pumps in one of three operational modes: DRY WEATHER PRIMARY EFFLUENT, WET WEATHER PRIMARY EFFLUENT, and WET WEATHER PRIMARY INFLUENT. For each mode, there will be a monitoring flow, control device, and a setpoint, which will be different for each mode (see table below). See Appendix A for the relative position of each valve in the three operating modes.

Mode	Monitoring Flow	Control Device	Set Point Equal
Dry Weather PE	Secondary Influent	EQ Pumps	Influent Flow (7-day rolling average)
Wet Weather PE	Influent Flow	EQ Pumps	9 MGD
Wet Weather PI	Primary Influent	EQ Primary Influent Modulating Weir Gate (EQ-GAT3)	9 MGD

- i. **DRY WEATHER PRIMARY EFFLUENT:** In dry weather operation, treated primary effluent will be stored in the EQ basins and then discharged to even out diurnal flows to the secondary treatment process. Primary effluent will be diverted from the primary effluent pipeline from Primary Clarifier No. 2 and pumped to the EQ distribution box. Return flow will be pumped from the EQ basins back into the primary effluent line from Primary Clarifier No. 2. In order to balance flows throughout the day, two submodes of operation; Storage and Drainage modes will be used. The selection of the two submodes will be made by the plant PLC in order to maintain a constant Secondary Influent Setpoint. The Secondary Influent flow Setpoint will be set by the plant PLC to equal the plant's seven-day running average influent flow (HW-FLW1-FIT-01). The plant PLC will determine Storage or Drainage submode based on the following conditions:

1. If Influent Flow (60 minute running average) is 10% greater than the Secondary Influent Setpoint for more than 20 minutes the PLC will operate in Storage submode.
2. If Influent Flow (60 minute running average) is 10% less than the Secondary Influent Setpoint for more than 20 minutes the PLC will operate in Drainage submode.
3. If Influent Flow (60 minute running average) is equal to or 10% less than the Secondary Influent Setpoint for greater than 20 minutes:
 - a. If the level in the either EQ Basin is (as measured by Level Indicating Transmitter EQ1-LIT-01/EQ2-LIT-01) above low level set point (initially set at Elevation 5 ft), the system shall operate in Drainage submode.
 - b. If the level in the EQ Basins is (as measured by Level Indicating Transmitter EQ1-LIT-01/EQ2-LIT-01) at or below the low level set point, the system shall operate in Standby mode, where all valve/gate settings are left unchanged and the EQ return pumps are turned off.
4. If Influent Flow (60 minute running average) is between 0% to 10% greater than of the Secondary Influent Setpoint for greater than 20 minutes the system shall operate in Standby mode, where all valve/gate settings are left unchanged and the EQ return pumps are turned off.

Under this mode of operation Secondary Influent shall be equal to:

1. Storage Submode: Influent Flow (HW-FLW1-FIT-01) minus EQ Pump Flow (EQ-FIT-01), If EQ-PVLV10-05 is Open, or

2. Drainage Submode: Influent Flow (HW-FLW1-FIT-01) plus EQ Pump Flow (EQ-FIT-01), If EQ-PVLV10-04 is Open

Storage Submode: Storage submode will begin if Influent Flow (60 minute running average) is 10% greater than the Secondary Influent Setpoint for more than 20 minutes. In the Storage submode flow will be stored in either EQ Basin 1 or 2 or both. EQ Basin No.1 Gate (EQ-GAT1) and EQ Basin No. 2 (EQ-GAT2) will be open manually to direct primary effluent to the desired basin(s). The EQ Primary Influent Modulating Weir Gate (EQ-GAT3) will be closed (i.e. set at its highest elevation). PLC will confirm that at least one of EQ-GAT1 and/or EQ-GAT2 is open and EQ-GAT3 is closed. If one EQ basin fills up to the connecting flap gate invert elevation water will passively overflow to the adjacent basin.

PE Suction Valves (EQ-PMP1-PVLV10-02 and EQ-PMP2-PVLV10-02) should be in the open position. EQ Suction Valves (EQ-PMP1-PVLV10-01 and EQ-PMP2-PVLV10-01) should be in the closed position. Headworks Return Valve (EQ-PVL10-05) to the EQ diversion box should be in the open position. PE Return Valve (EQ-PVLV10-04) to the Primary Effluent line should be in the closed position. The EQ Return – Gate No. 2 (EQ-GAT5) should be in the open position. The EQ Return – Gate No. 1 (EQ-GAT4) should be in the closed position.

Under the Storage submode of operation Secondary Influent shall be equal to Influent Flow (HW-FLW1-FIT-01) minus EQ Pump Flow (EQ-FIT-01).

The required pump speed will be output by the control algorithm and will be adjusted based on the measured influent flow and measured pump flow.

On rising (MONITORING FLOW) the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) rises above the (SET POINT) the duty pump will start and come up to 45% speed.
2. If the (MONITORING FLOW) continues to increase above the (SET POINT) for some duration (operator set point, initially set at 1 minutes), the pump speed will increase by 10%.
3. If the duty pump reaches 100% speed and (MONITORING FLOW) continues to increase above the (SET POINT), the standby pump will start and come up to 60% speed and the duty pump will reduce to the same speed.

4. With both pumps in operation, if (MONITORING FLOW) continues to increase, the pump speeds will increase uniformly to maintain flow. If both pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%) the “system demand exceeds pump capacity” alarm shall be activated.

On (MONITORING FLOW) falling the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) falls below the (SET POINT), the pump speed(s) will decrease by 10%.
2. If two pumps are in operation and they reach a low transition speed set point (initially set at 45%), the standby pump shall drop off line and the duty pump shall increase to the one pump transition set point (initially set at 80%).
3. If only one pump is in operation and the pump speed reaches the cutoff speed set point (initially set at 45%), the duty pump will turn off.

- ii. **Drainage Submode:** In dry weather operation, stored primary effluent will be pumped back into the Primary Clarifier No. 2 primary effluent line.

If primary effluent is stored in both EQ Basins, Basin 1 will be drained before Basin 2. The Drainage submode will begin when Influent Flow (60 minute running average) is 10% less than the Secondary Influent Setpoint for more than 20 minutes. The EQ Suction Valves (EQ-PMP1-PVLV10-01 and EQ-PMP2-PVLV10-01) should be in the open position. PE Suction Valves (EQ-PMP1-PVLV10-02 and EQ-PMP2-PVLV10-02) should be in the closed position. Headworks Return Valve (EQ-PVL10-05) to the EQ diversion box should be in the closed position. PE Return Valve (EQ-PVLV10-04) to the Primary Effluent line should be in the open position. The EQ Primary Influent Modulating Weir Gate (EQ-GAT3) should be closed (i.e. set at its highest elevation).

Under the Drainage Submode of operation Secondary Influent shall be equal to Influent Flow (HW-FLW1-FIT-01) plus EQ Pump Flow (EQ-FIT-01).

On falling (MONITORING FLOW) the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) falls below the (SET POINT) the duty pump will start and come up to 45% speed.

2. If the (MONITORING FLOW) continues to decrease below the (SET POINT) for some duration (operator set point, initially set at 1 minute), the pump speed will increase by 10%.
3. If the duty pump reaches 100% speed and (MONITORING FLOW) continues to decrease below the (SET POINT), the standby pump will start and come up to 60% speed and the duty pump will reduce to the same speed.
4. With both pumps in operation, if (MONITORING FLOW) continues to decrease, the pump speeds will increase uniformly to maintain flow. If both pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%) the "system demand exceeds pump capacity" alarm shall be activated.

On (MONITORING FLOW) rising the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) rises above the (SET POINT), the pump speed(s) will decrease by 10%.
2. If two pumps are in operation and they reach a low transition speed set point (initially set at 45%), the standby pump shall drop off line and the duty pump shall increase to the one pump transition set point (initially set at 80%).
3. If only one pump is in operation and the pump speed reaches the cutoff speed set point (initially set at 45%), the duty pump will turn off.

- iii. WET WEATHER PRIMARY EFFLUENT: The Wet Weather Primary Effluent automatic mode will be identical to the dry weather primary effluent mode except that the Secondary Influent setpoint will be fixed at 9 MGD and the Drainage submode will continue until the EQ basins are emptied. In wet weather operation, treated primary effluent will be stored in the EQ basins to limit flow to the secondary treatment process to 9 MGD. Primary effluent will be pulled from the primary effluent pipeline from Primary Clarifier No. 2 and pumped to the EQ distribution box. Return flow will be pumped from the EQ basins back into the primary effluent line from Primary Clarifier No. 2, in order to empty the EQ basins. Two submodes of operation; Storage and Drainage modes will be used. The selection of the two submodes will be made by the plant PLC in order to keep flow at or less than Secondary Influent Setpoint until the EQ basins are full or emptied. The Secondary Influent flow Setpoint will be set by the plant PLC to 9 MGD. The plant PLC will determine Storage or Drainage submode based on the following conditions:

1. If Influent Flow is greater than the Secondary Influent Setpoint for more than 5 minutes the PLC will operate in Storage submode.
2. If Influent Flow is 5% less than the Secondary Influent Setpoint for more than 10 minutes the PLC will operate in Drainage submode.
3. If Influent Flow (60 minute running average) is equal to or 5% less than the Secondary Influent Setpoint for greater than 10 minutes the system shall operate in current operating submode (either Storage or Drainage).

Under this mode of operation Secondary Influent shall be equal to:

1. Storage Submode: Influent Flow (HW-FLW1-FIT-01) minus EQ Pump Flow (EQ-FIT-01), If EQ-PVLV10-05 is Open, or
2. Drainage Submode: Influent Flow (HW-FLW1-FIT-01) plus EQ Pump Flow (EQ-FIT-01), If EQ-PVLV10-04 is Open

Storage Submode: Storage submode will begin if Influent Flow is 5% greater than the Secondary Influent Setpoint for more than 5 minutes. In the Storage submode flow will be stored in either EQ Basin 1 or 2 or both. EQ Basin No.1 Gate (EQ-GAT1) and EQ Basin No. 2 (EQ-GAT2) will be open manually to direct primary effluent to the desired basin(s). The EQ Primary Influent Modulating Weir Gate (EQ-GAT3) will be closed (i.e. set at its highest elevation). PLC will confirm that at least one of EQ-GAT1 and/or EQ-GAT2 is open and EQ-GAT3 is closed. If one EQ basin fills up to the connecting flap gate invert elevation water will passively overflow to the adjacent basin. PE Suction Valves (EQ-PMP1-PVLV10-02 and EQ-PMP2-PVLV10-02) should be in the open position. EQ Suction Valves (EQ-PMP1-PVLV10-01 and EQ-PMP2-PVLV10-01) should be in the closed position. Headworks Return Valve (EQ-PVL10-05) to the EQ diversion box should be in the open position. PE Return Valve (EQ-PVLV10-04) to the Primary Effluent line should be in the closed position. The EQ Return – Gate No. 2 (EQ-GAT5) should be in the open position. The EQ Return – Gate No. 1 (EQ-GAT4) should be in the closed position.

Under the Storage submode of operation Secondary Influent shall be equal to Influent Flow (HW-FLW1-FIT-01) minus EQ Pump Flow (EQ-FIT-01). The required pump speed will be determined by the control algorithm and will be adjusted based on the measured influent flow and measured pump flow.

On rising (MONITORING FLOW) the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) rises above the (SET POINT) the duty pump will start and come up to 45% speed.
2. If the (MONITORING FLOW) continues to increase above the (SET POINT) for some duration (operator set point, initially set at 1 minute), the pump speed will increase by 10%.
3. If the duty pump reaches 100% speed and (MONITORING FLOW) continues to increase above the (SET POINT), the standby pump will start and come up to 60% speed and the duty pump will reduce to the same speed.
4. With both pumps in operation, if (MONITORING FLOW) continues to increase, the pump speeds will increase uniformly to maintain flow. If both pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%) the “system demand exceeds pump capacity” alarm shall be activated.

On (MONITORING FLOW) falling the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) falls below the (SET POINT), the pump speed(s) will decrease by 10%.
2. If two pumps are in operation and they reach a low transition speed set point (initially set at 45%), the standby pump shall drop off line and the duty pump shall increase to the one pump transition set point (initially set at 80%).
3. If only one pump is in operation and the pump speed reaches the cutoff speed set point (initially set at 45%), the duty pump will turn off.

Storage submode shall end if EQ Basin 1 or 2 (as measured by float or Level Indicating Transmitter EQ1-LIT-01/EQ2-LIT-01) reaches the high-high level set point (initially set at Elevation 39 ft). When the water level reaches the high-high level set point, the EQ pumps will turn off. Storage submode shall be locked out until the water level in the EQ Basins drops below the high-high level.

- iv. **Drainage Submode:** In wet weather operation, stored primary effluent will be pumped back into the Primary Clarifier No. 2 primary effluent line.

If primary effluent is stored in both EQ Basins, Basin 1 will be drained before Basin 2. If Influent Flow is 5% less than the Secondary Influent Setpoint for more than 10 minutes the PLC will operate in Drainage submode. The EQ Suction Valves (EQ-PMP1-PVLV10-01 and EQ-PMP2-PVLV10-01) should be in the open position. PE Suction Valves (EQ-PMP1-PVLV10-02 and EQ-PMP2-PVLV10-02) should be in the closed position. Headworks Return Valve (EQ-PVL10-05) to the EQ diversion box should be in the closed position. PE Return Valve (EQ-PVLV10-04) to the Primary Effluent line should be in the open position. The EQ Primary Influent Modulating Weir Gate (EQ-GAT3) should be closed (i.e. set at its highest elevation).

Under the Drainage Submode of operation Secondary Influent shall be equal to Influent Flow (HW-FLW1-FIT-01) plus EQ Pump Flow (EQ-FIT-01).

On falling (MONITORING FLOW) the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) falls below the (SET POINT) the duty pump will start and come up to 45% speed.
2. If the (MONITORING FLOW) continues to decrease below the (SET POINT) for some duration (operator set point, initially set at 1 minute), the pump speed will increase by 10%.
3. If the duty pump reaches 100% speed and (MONITORING FLOW) continues to decrease below the (SET POINT), the standby pump will start and come up to 60% speed and the duty pump will reduce to the same speed.
4. With both pumps in operation, if (MONITORING FLOW) continues to decrease, the pump speeds will increase uniformly to maintain flow. If both pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%) the "system demand exceeds pump capacity" alarm shall be activated.

On (MONITORING FLOW) rising the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) rises above the (SET POINT), the pump speed(s) will decrease by 10%.
2. If two pumps are in operation and they reach a low transition speed set point (initially set at 45%), the standby pump shall drop off line and the duty pump shall increase to the one pump transition set point (initially set at 80%).

3. If only one pump is in operation and the pump speed reaches the cutoff speed set point (initially set at 45%), the duty pump will turn off.

Unless a Storage submode condition occurs, Drainage submode shall continue until the level in the EQ Basins (as measured by Level Indicating Transmitter EQ1-LIT-01/EQ2-LIT-01) reaches the low level set point (initially set at Elevation 5 ft). When the water level reaches the low level set point, the EQ pump(s) will turn off.

- v. **WET WEATHER PRIMARY INFLUENT:** The Wet Weather Primary Influent automatic mode will be similar to the Wet Weather Primary Effluent mode except that the Primary Influent will be stored and the Primary Influent setpoint will be fixed at 9 MGD. In wet weather operation, primary influent will be stored in the EQ basins to limit flow to the primary clarifiers and thereby the secondary process, to 9 MGD. Primary influent to be stored will be pulled from the primary influent channel the EQ distribution box. Return flow will be pumped from the EQ basins back into the primary influent channel, in order to empty the EQ basins. Two submodes of operation; Storage and Drainage modes will be used. The selection of the two submodes will be made by the plant PLC in order to keep flow at or less than Primary Influent Setpoint until the EQ basins are full or emptied. The Primary Influent flow Setpoint will be set by the plant PLC to 9 MGD. The plant PLC will determine Storage or Drainage submode based on the following conditions:

1. If Influent Flow is greater than the Secondary Influent Setpoint for more than 5 minutes the PLC will operate in Storage submode.
2. If Influent Flow is 5% less than the Secondary Influent Setpoint for more than 10 minutes the PLC will operate in Drainage submode.
3. If Influent Flow (60 minute running average) is equal to or 5% less than the Secondary Influent Setpoint for greater than 10 minutes the system shall operate in current operating submode (either Storage or Drainage).

Primary Influent flow will be calculated based on the water level measurement from Primary Influent Channel Level Element/Transmitter (HW-FLW1-LIT-02), the position (elevation) and length of the EQ Primary Influent Modulating Weir Gate (EQ-GAT3), the length and elevations of the primary influent weirs to both clarifiers, and EQ Pump Flow (EQ-FIT-01) according to the following:

Sharp-Crested Weir Head-Discharge Equation:

$$Q = 3.33LH^{\frac{3}{2}}$$

Where:

Q: Flow (cubic ft per sec)

L: Weir length (ft)

H: Head over weir (ft)

Under this mode of operation Primary Influent shall be equal to:

1. Storage Submode: Flow to Primary Clarifier No. 1 plus flow to Primary Clarifier No. 2 minus flow to EQ, where:

Flow	Weir	Weir Elevation (ft)	Weir Length (ft)	Flow Equation
To Primary Clarifier No. 1	EQ-GAT3	HW-FLW1-LIT-02	3	$(3.33)(3)[(HW-FLW1-LIT-02) - 37]^{\frac{3}{2}}$
To Primary Clarifier No. 2	Primary Clarifier No. 1 Primary Influent Weir	37	3	$(3.33)(3)[(HW-FLW1-LIT-02) - 37]^{\frac{3}{2}}$
To EQ	Primary Clarifier No. 2 Primary Influent Weir	37	3	$(3.33)(3)[(HW-FLW1-LIT-02) - (EQ-GAT3-ZIT-01)]^{\frac{3}{2}}$

2. Drainage Submode: Flow to Primary Clarifier No. 1 plus flow to Primary Clarifier No. 2 plus EQ Pump Flow, where:

Flow	Weir	Weir Elevation (ft)	Weir Length (ft)	Flow Equation
To Primary Clarifier No. 1	EQ-GAT3	HW-FLW1-LIT-02	3	$(3.33)(3)[(HW-FLW1-LIT-02) - 37]^{\frac{3}{2}}$
To Primary Clarifier No. 2	Primary Clarifier No. 1 Primary Influent Weir	37	3	$(3.33)(3)[(HW-FLW1-LIT-02) - 37]^{\frac{3}{2}}$
EQ Pump Flow	-	-	-	EQ-FIT-01

Storage Submode: Storage submode will begin if Influent Flow is 5% greater than the Primary Influent Setpoint for more than 5 minutes. In the Storage submode flow will be stored in either EQ Basin 1 or 2 or both. EQ Basin No.1 Gate (EQ-GAT1) and EQ Basin No. 2 (EQ-GAT2) will be open manually to direct primary effluent to the desired basin(s). The EQ Primary Influent Modulating Weir Gate (EQ-GAT3) will be controlled by the plant PLC to direct flow to the EQ Basins and achieve the desired Primary Influent flow to the primary clarifiers. PLC will confirm that at least one of EQ-GAT1 and/or EQ-GAT2 is open. If one EQ basin fills up to the connecting flap gate invert elevation water will passively overflow to the adjacent basin.

PE Suction Valves (EQ-PMP1-PVLV10-02 and EQ-PMP2-PVLV10-02) should be in the closed position. EQ Suction Valves (EQ-PMP1-PVLV10-01 and EQ-PMP2-PVLV10-01) should be in the closed position. Headworks Return Valve (EQ-PVL10-05) to the EQ diversion box should be in the closed position. PE Return Valve (EQ-PVLV10-04) to the Primary Effluent line should be in the closed position. The EQ Return – Gate No. 2 (EQ-GAT5) should be in the closed position. The EQ Return – Gate No. 1 (EQ-GAT4) should be in the closed position.

Under the Storage submode of operation Primary Influent shall be equal to flow to Primary Clarifier No. 1 plus flow to Primary Clarifier No. 2 minus flow to EQ.

On rising (MONITORING FLOW) the modulating gate operational sequence shall be as follow:

1. When the (MONITORING FLOW) rises above the (SET POINT) the gate shall be lowered by 10 percent.
2. If (MONITORING FLOW) continues to increase above the (SET POINT) for some duration (operator set point, initially set at 1 minute), the gate shall be lowered by 10 percent to maintain flow.

On (MONITORING FLOW) falling the modulating gate operational sequence shall be as follow:

1. When the (MONITORING FLOW) falls below the (SET POINT) the gate shall be raised by 10 percent.
2. If the (MONITORING FLOW) continues to fall above the (SET POINT) for some duration (operator set point, initially set at 1 minute), the gate shall be raised by 10 percent to maintain flow.

Storage submode shall end of EQ Basin 1 or 2 (as measured by float or Level Indicating Transmitter EQ1-LIT-01/EQ2-LIT-01) reaches the high-high level set point (initially set at Elevation 39 ft). When the water level reaches the high-high set point, the gate will close. Storage submode shall be locked out until the water level in the EQ basins drops below the high-high level.

Drainage Submode: In wet weather operation, stored primary influent will be pumped into the Headworks Return Box and will flow passively into the primary influent channel.

If primary influent is stored in both EQ Basins, Basin 1 will be drained before Basin 2. The Drainage submode will begin when Influent Flow (60 minute running average) is 5% less than the Primary Influent Setpoint for more than 10 minutes.

The EQ Suction Valves (EQ-PMP1-PVLV10-01 and EQ-PMP2-PVLV10-01) should be in the open position. PE Suction Valves (EQ-PMP1-PVLV10-02 and EQ-PMP2-PVLV10-02) should be in the closed position. Headworks Return Valve (EQ-PVL10-05) should be in the closed position. PE Return Valve (EQ-PVLV10-04) to the Primary Effluent line should be in the closed position. The EQ Return – Gate No. 2 (EQ-GAT5) should be in the closed position. The EQ Return – Gate No. 1 (EQ-GAT4) to the Headworks Return Box should be in the open position. The EQ Primary Influent Modulating Weir Gate (EQ-GAT3) should be closed (i.e. set at its highest elevation).

Under the Drainage Submode of operation Primary Influent shall be equal to flow to Primary Clarifier No. 1 plus flow to Primary Clarifier No. 2 plus EQ Pump Flow. The required pump speed will be determined by the control algorithm and will be adjusted based on the measured influent flow and measured pump flow.

On falling (MONITORING FLOW) the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) falls below the (SET POINT) the duty pump will start and come up to 45% speed.
2. If the (MONITORING FLOW) continues to decrease below the (SET POINT) for some duration (operator set point, initially set at 1 minutes), the pump speed will increase by 10%.

3. If the duty pump reaches 100% speed and (MONITORING FLOW) continues to decrease below the (SET POINT), the standby pump will start and come up to 60% speed and the duty pump will reduce to the same speed.
4. With both pumps in operation, if (MONITORING FLOW) continues to decrease, the pump speeds will increase uniformly to maintain flow. If both pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%) the “system demand exceeds pump capacity” alarm shall be activated.

On (MONITORING FLOW) rising the pump operational sequence shall be as follows:

1. When the (MONITORING FLOW) rises above the (SET POINT), the pump speed(s) will decrease by 10%.
2. If two pumps are in operation and they reach a low transition speed set point (initially set at 45%), the standby pump shall drop off line and the duty pump shall increase to the one pump transition set point (initially set at 80%).
3. If only one pump is in operation and the pump speed reaches the cutoff speed set point (initially set at 45%), the duty pump will turn off.

Unless a Storage submode condition occurs, Drainage submode shall continue until the level in the EQ Basins (as measured by Level Indicating Transmitter EQ1-LIT-01/EQ2-LIT-01) reaches the low level set point (initially set at Elevation 5 ft). When the water level reaches the low level set point, the EQ pump(s) will turn off.

B. Manual Mode:

1. Equalization Pumps

Grit pumps will operate according to the HAND-OFF-AUTO selector switch.

2. Modulating Weir Gate

The gate shall have vendor supplied OPEN-STOP-CLOSE control stations that include “open” and “closed” limit switches in addition to a position transmitter that provides a continuous position signal to the PLC system.

2. The SCADA screen(s) shall display the following variables and status for each piece of equipment:

- a. Equalization Pump No. 1 – RUN, FAIL, in AUTO, Low and High Pressure Alarm
 - b. Equalization Pump No. 2 – RUN, FAIL, in AUTO, Low and High Pressure Alarm
 - c. Equalization Pumps – FLOW (EQ-PVLV10-FIT-01)
 - d. Equalization Pump No. 1 – Mode (DRY WEATHER PRIMARY EFFLUENT, WET WEATHER PRIMARY EFFLUENT, WET WEATHER PRIMARY INFLUENT)
 - e. Equalization Pump No. 2 – Mode (DRY WEATHER PRIMARY EFFLUENT, WET WEATHER PRIMARY EFFLUENT, WET WEATHER PRIMARY INFLUENT)
 - f. Equalization Basin 1 Water Level (EQ1-LIT-01)
 - g. Equalization Basin 2 Water Level (EQ2-LIT-01)
 - h. Equalization Basin 1 Low-Low Level Alarm (Software function for LIT)
 - i. Equalization Basin 2 Low-Low Level Alarm (Software function for LIT)
 - j. Equalization Basin 1 Low Level Alarm (Software function for LIT)
 - k. Equalization Basin 2 Low Level Alarm (Software function for LIT)
 - l. Equalization Basin 1 High Level Alarm (Software function for LIT)
 - m. Equalization Basin 2 High Level Alarm (Software function for LIT)
 - n. Equalization Basin 1 High-High Level Alarm (EQ1-LSHH-01)
 - o. Equalization Basin 2 High-High Level Alarm (EQ2-LSHH-01)
 - p. Valve Status including position
 - q. Gate Status including position
 - r. Gate percent open
 - s. “System Requests Exceed Pump Capacity” (both pumps at 100% [set point] speed)
3. Software Interlocks:
- a. The pumps shall not operate below the low-low level (wired directly to VFD)
4. Trend Variables:
- a. EQ Pump Speed each
 - b. EQ Basin level each
5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
- a. Manual Start/Stop: Yes
 - b. Manual Speed Control: Yes
 - c. Manual/PLC Selection: Yes
 - d. Open and close headworks/EQ gates

APPENDIX A - OPERATING MODE VALVE POSITIONS

Mode	Submode	Gate/Valve Description	Gate/Valve Number	Position
Dry Weather Primary Effluent	Storage	EQ Basin No. 1 Influent Gate	EQ-GAT1	OPEN
		EQ Basin No. 2 Influent Gate	EQ-GAT2	OPEN
		EQ Primary Influent Modulating Weir Gate	EQ-GAT3	CLOSED
		EQ Pump No. 1 EQ Suction Plug Valve	EQ-PMP1-PVLV10-01	CLOSED
		EQ Pump No. 2 EQ Suction Plug Valve	EQ-PMP2-PVLV10-01	CLOSED
		EQ Pump No. 1 PE Suction Plug Valve	EQ-PMP1-PVLV10-02	OPEN
		EQ Pump No. 2 PE Suction Plug Valve	EQ-PMP2-PVLV10-02	OPEN
		Primary Effluent Return Plug Valve	EQ-PVLV10-04	CLOSED
		Headworks Return Plug Valve	EQ-PVLV10-05	OPEN
		EQ Return – Gate No. 2	EQ-GAT5	OPEN
		EQ Return – Gate No. 1	EQ-GAT4	CLOSED
	Drainage	EQ Basin No. 1 Influent Gate	EQ-GAT1	CLOSED
		EQ Basin No. 2 Influent Gate	EQ-GAT2	CLOSED
		EQ Primary Influent Modulating Weir Gate	EQ-GAT3	CLOSED
		EQ Pump No. 1 EQ Suction Plug Valve	EQ-PMP1-PVLV10-01	OPEN
		EQ Pump No. 2 EQ Suction Plug Valve	EQ-PMP2-PVLV10-01	OPEN
		EQ Pump No. 1 PE Suction Plug Valve	EQ-PMP1-PVLV10-02	CLOSED
		EQ Pump No. 2 PE Suction Plug Valve	EQ-PMP2-PVLV10-02	CLOSED
		Primary Effluent Return Plug Valve	EQ-PVLV10-04	OPEN
		Headworks Return Plug Valve	EQ-PVLV10-05	CLOSED
		EQ Return – Gate No. 2	EQ-GAT5	CLOSED
		EQ Return – Gate No. 1	EQ-GAT4	CLOSED
Wet Weather Primary Effluent	Storage	EQ Basin No. 1 Influent Gate	EQ-GAT1	OPEN
		EQ Basin No. 2 Influent Gate	EQ-GAT2	OPEN
		EQ Primary Influent Modulating Weir Gate	EQ-GAT3	CLOSED
		EQ Pump No. 1 EQ Suction Plug Valve	EQ-PMP1-PVLV10-01	CLOSED
		EQ Pump No. 2 EQ Suction Plug Valve	EQ-PMP2-PVLV10-01	CLOSED
		EQ Pump No. 1 PE Suction Plug Valve	EQ-PMP1-PVLV10-02	OPEN
		EQ Pump No. 2 PE Suction Plug Valve	EQ-PMP2-PVLV10-02	OPEN
		Primary Effluent Return Plug Valve	EQ-PVLV10-04	CLOSED
		Headworks Return Plug Valve	EQ-PVLV10-05	OPEN
		EQ Return – Gate No. 2	EQ-GAT5	OPEN
		EQ Return – Gate No. 1	EQ-GAT4	CLOSED
	Drainage	EQ Basin No. 1 Influent Gate	EQ-GAT1	CLOSED
		EQ Basin No. 2 Influent Gate	EQ-GAT2	CLOSED

Mode	Submode	Gate/Valve Description	Gate/Valve Number	Position
		EQ Primary Influent Modulating Weir Gate	EQ-GAT3	CLOSED
		EQ Pump No. 1 EQ Suction Plug Valve	EQ-PMP1-PVLV10-01	OPEN
		EQ Pump No. 2 EQ Suction Plug Valve	EQ-PMP2-PVLV10-01	OPEN
		EQ Pump No. 1 PE Suction Plug Valve	EQ-PMP1-PVLV10-02	CLOSED
		EQ Pump No. 2 PE Suction Plug Valve	EQ-PMP2-PVLV10-02	CLOSED
		Primary Effluent Return Plug Valve	EQ-PVLV10-04	OPEN
		Headworks Return Plug Valve	EQ-PVLV10-05	CLOSED
		EQ Return – Gate No. 2	EQ-GAT5	CLOSED
		EQ Return – Gate No. 1	EQ-GAT4	CLOSED
Wet Weather Primary Influent	Storage	EQ Basin No. 1 Influent Gate	EQ-GAT1	OPEN
		EQ Basin No. 2 Influent Gate	EQ-GAT2	OPEN
		EQ Primary Influent Modulating Weir Gate	EQ-GAT3	OPEN
		EQ Pump No. 1 EQ Suction Plug Valve	EQ-PMP1-PVLV10-01	CLOSED
		EQ Pump No. 2 EQ Suction Plug Valve	EQ-PMP2-PVLV10-01	CLOSED
		EQ Pump No. 1 PE Suction Plug Valve	EQ-PMP1-PVLV10-02	CLOSED
		EQ Pump No. 2 PE Suction Plug Valve	EQ-PMP2-PVLV10-02	CLOSED
		Primary Effluent Return Plug Valve	EQ-PVLV10-04	CLOSED
		Headworks Return Plug Valve	EQ-PVLV10-05	CLOSED
		EQ Return – Gate No. 2	EQ-GAT5	CLOSED
		EQ Return – Gate No. 1	EQ-GAT4	CLOSED
	Drainage	EQ Basin No. 1 Influent Gate	EQ-GAT1	CLOSED
		EQ Basin No. 2 Influent Gate	EQ-GAT2	CLOSED
		EQ Primary Influent Modulating Weir Gate	EQ-GAT3	CLOSED
		EQ Pump No. 1 EQ Suction Plug Valve	EQ-PMP1-PVLV10-01	OPEN
		EQ Pump No. 2 EQ Suction Plug Valve	EQ-PMP2-PVLV10-01	OPEN
		EQ Pump No. 1 PE Suction Plug Valve	EQ-PMP1-PVLV10-02	CLOSED
		EQ Pump No. 2 PE Suction Plug Valve	EQ-PMP2-PVLV10-02	CLOSED
		Primary Effluent Return Plug Valve	EQ-PVLV10-04	CLOSED
		Headworks Return Plug Valve	EQ-PVLV10-05	OPEN
		EQ Return – Gate No. 2	EQ-GAT5	CLOSED
		EQ Return – Gate No. 1	EQ-GAT4	OPEN

A. References:

Drawings : I100-1
PLC: PLC-HW located in MCC room.

B. Summary Description:

Influent flow measurement will be achieved using a Parshall flume just downstream of the grit removal process and will be the influent flow measurement for the treatment plant. Flow will be calculated by the PLC based on the water level measured at influent side of the flume. Total primary influent flow will also be measured and will be calculated using a water level measurement in the primary influent channel. Primary influent can be sent to Primary Clarifier No. 1, Primary Clarifier No. 2 and/or to Equalization. The distribution of primary influent flow will be estimated based on the controlling weir elevations for the respective destinations.

C. Field Controls and Instrumentations:

1. Instrumentation

- a. Ultrasonic (at Parshall Flume): HW-FLW1-LIT-01
- b. Ultrasonic (in Primary Influent Distribution Box): HW-FLW1-LIT-02

2. Local Control Devices

- 1.) None

3. Hardwired Interlocks

- a. None

4. Local Process Indicators and Alarms

- a. Screens
 - 1.) Flows from transmitters
- b. Shaftless Screw Conveyor
 - 1.) NO/SLOW SPEED (See packaged equipment I/O list)
 - 2.) E-STOP activated (See packaged equipment I/O list)

5. MCC Status/Control Functions:

- a. None

D. PLC/SCADA Monitoring and Control Functions

- a. Screens
 - 1.) See packaged equipment I/O list
 - 2.) Screen ON
 - 3.) Screen RUN (monitoring)

- 4.) E-STOP (monitoring)
- b. Shaftless Screw Conveyor
 - 1.) RUN, FAIL, in AUTO
 - 2.) AUTO mode selectable based on time or screen operation
 - 3.) E-STOP (monitoring)

1. Control (Manufacturer supplied LCP SC-EQP1/2-LCP-01)

A. Automatic Mode:

1. Screen - Brush

When the screen selector is in the AUTO position the screen will begin to run due to any of the following conditions:

- i. Level rises (SC-EQP1-LIT-01, SC-EQP2-LIT-01) and remains above the start level setpoint for the time set in the level start delay timer.
- ii. Screen has remained off for the time set in the screen off timer
- iii. System reset pushbutton pressed and held for 3 seconds

Once the screen starts it will run continuously in the forward direction until the level drops below the start level setpoint, per the time setting in the screen off delay timer.

Screen cleaning cycle: A screen cleaning cycle will be initiated after the screen has run for the time set in the screen accumulated run timer. The screen will stop, dwell, run reverse for the time set in the screen cleaning reverse run time, stop, dwell and continue forward if a call to run is still present.

3. Screen - Press Zone Spray Wash

When the press zone wash selector is in the AUTO position, the press zone wash will cycle on and off, on time first, per repeat cycle times set in the plc, independent of the screen operation.

4. Screen - Wash Water

When the wash selector is in the AUTO position, the wash will cycle on and off, on time first, per repeat cycle times set in the plc, any time the screen is operating in the forward direction.

5. Shaftless Screw Conveyor

When the SCADA AUTO mode is selected (and local control is in REMOTE), the conveyor shall have the following operator selectable modes of operation:

- i. Time: ON for 2 minutes, every 20 minutes.
- ii. Move in conjunction with screen operation: ON for 5 minutes each time a screen cycles through operation.

B. Manual Mode:

1. Screen - Brush

When the screen selector is in the HAND position, the screen will cycle on and off with the screen FOR-OFF-REV selector.

- i. FOR: When the screen selector is in the HAND position, and the forward direction is selected, the screen will run continuously in the forward direction.
- ii. REV: when the screen selector is in the HAND position and the reverse direction selected, the screen will run continuously in the reverse direction. This switch will spring return from REV to OFF.

2. Screen - Press Zone Spray Wash

When the press zone wash selector is in the HAND position, the press zone wash will run continuously.

3. Screen - Wash Water

When the wash selector is in the HAND position, the wash will run continuously.

4. Screen - Emergency Stop

When any of the E-STOP pushbuttons are pressed the screen and spray washes will stop immediately, the control power on light will de-energize. To reset, ensure all e-stops are enabled, and press the system reset pushbutton.

5. Shaftless Screw Conveyor

- i. ON: When the hand selector switch is in the ON position, the conveyor will run continuously.
- ii. E-STOP: When any of the E-STOP pushbuttons are pressed the shaft less screw conveyor will stop immediately, the control power on light will de-energize. To reset, ensure all e-stops are enabled, and press the system reset pushbutton.

2. The SCADA screen(s) shall display the following variables and status:

- a. For each screen:
 1. Level in front of screen
 2. RUN
 3. FAIL
 4. High Level alarm
- b. Shaftless Screw Conveyor
 1. RUN
 2. No/Slow Speed Alarm
 3. E-STOP activated

3. Software Interlocks: NONE

4. Trend Variables:

- a. Level in front of screen
- b. Screen RUN time
- c. Screen starts per hour
- d. Screw conveyor starts per hour

5. Operator Functions from SCADA Screens when selector switch in PLC Mode:

- a. Manual Start/Stop: Yes
- b. Manual Speed Control: No
- c. Manual/PLC Selection: No

CS-210**PRIMARY CLARIFIER NO. 2**

- A. References:
- Drawings: I200-1
- PLC: PLC-HW located in MCC room

B. Summary Description:

There is one new primary clarifier, PC2 and one existing primary clarifier PC1. The new primary clarifier will be controlled independently of PC1. The clarifier includes sludge/scum collection (see also Primary Sludge/Scum Pumping Controls). The sludge collectors operate continuously, under local control only. Operations staff will select ON whenever the clarifiers are receiving primary influent. A manufacturer supplied Local Control Station provides local control of the drive and the scum trough washwater solenoid. Torque and sheer pin status for the clarifier drive is monitored. There is also a position switch to detect skimmer arm rotation. The skimmer arm position switch is used to open the scum trough washwater solenoid valve for a timed duration each time the skimming arm trips the arm position switch.

C. Field Controls and Instrumentations:

1. Instrumentation
 - a. Skimmer Scum Box Switch: PC2-DRV1-ZSH-01
 - b. Skimmer Scum Box Spray Solenoid Valve: PC2-SVLV01-01
 - c. Scum Pit Spray Solenoid Valve: PC2-SVLV01-02
 - d. Clarifier Drive Torque Limit Switch – High: PC2-DRV1-NSH-01
 - e. Clarifier Drive Torque Limit Switch – High-High: PC2-DRV1-NSHH-01
 - f. Clarifier Drive Shear Pin Switch: PC2-DRV1-ZSH-01
2. Local Control Devices on LCP
 - a. Skimmer Scum Box Spray – ON/OFF/AUTO
 - b. Scum Pit Spray – ON/OFF/AUTO
 - c. Clarifier Drive – Start/Stop
3. Hardwired Interlocks
 - a. None
4. Local Process Indicators and Alarms
 - a. Clarifier Drive Torque Limit Switch – High torque
 - b. Clarifier Drive Torque Limit Switch – High High torque
 - c. Clarifier Drive Shear Pin Switch – Shut down alarm
 - d. Clarifier Drive RUN, FAIL
5. MCC Status/Control Functions:
 - a. None

- D. PLC/SCADA Monitoring and Control Functions
 - a. Torque Warning – High and High High Torque Alarm
 - b. Scum Pit Spray On/Off/Auto – Auto mode Indicator
 - c. Clarifier Drive RUN
 - d. Clarifier Drive FAIL/OVERLOAD
- 1. Control
 - A. **Automatic Mode**
 - 1. Scum Box Spray
Each time the scum scraper switch is activated the scum box the scum box solenoid shall open for a timed duration (initially set at 60 seconds) each time the skimmer arm trips the arm position switch.
 - 2. Scum Pit Spray
See primary sludge/scum pumping control description.
 - B. **Manual Mode:**
 - 1. Clarifier Drive and Sprays
Clarifier Drive and Sprays will operate according to the ON/OFF selector.
- 2. The SCADA screen(s) shall display the following variables and status for each piece of equipment:
 - 1. Torque Warning – High or High High
 - 2. Primary Clarifier Trouble
 - 3. Scum Pit Spray On/Off/Remote – Remote Indicator
 - 4. Clarifier Drive ON
- 3. Software Interlocks: None.
- 4. Trend Variables:
 - a. Sludge/Scum Pump RUN time
 - b. Sludge/Scum Pump starts per hour
- 5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
 - a. Manual Start/Stop: Yes (Clarifier Drive)
 - b. Manual Start/Stop: Yes (Scum Pit Solenoid Valve)

CS-211**PRIMARY SLUDGE/SCUM PUMPING****A. References:**

Drawings: I200-1
PLC: PLC-HW located in MCC room.

B. Summary Description:

The primary sludge/scum pumping consists of two double disc pumps. The sludge pumps will operate such that one is used for primary sludge and the other is used for primary scum. The sludge pumps are constant speed pumps and are controlled by the PLC. In automatic mode, the designated primary sludge pump will operate based a selectable number of starts per hour for an adjustable timed duration. The designated primary scum pump will operate based on level in the scum wet well. Primary sludge and scum will be pumped to the primary digester.

C. Field Controls and Instrumentations:**1. Instrumentation**

- a. Primary Sludge/Scum Pump No. 1 – Suction Pressure Indicator/Low Switch: PC2-PMP1-PE-01/PC2-PMP1-PI-01/PC2-PMP1-PSL-01
- b. Primary Sludge/Scum Pump No. 2 – Suction Pressure Indicator/Low Switch: PC2-PMP2-PE-01/PC2-PMP2-PI-01/PC2-PMP2-PSL-01
- c. Primary Sludge/Scum Pump No. 1 – Discharge Pressure Indicator/High Switch: PC2-PMP1-PE-02/PC2-PMP1-PI-02/PC2-PMP1-PSH-01
- d. Primary Sludge/Scum Pump No. 2 – Discharge Pressure Indicator/High Switch: PC2-PMP2-PE-02/PC2-PMP2-PI-02/PC2-PMP2-PSH-01
- e. Primary Sludge/Scum Pump No. 1 – Flow meter: PC1-PMP1-FE-01/PC2-PMP1-FIT-01
- f. Primary Sludge/Scum Pump No. 2 – Flow meter: PC2-PMP2-FE-01/PC2-PMP2-FIT-01
- g. Primary scum pit level element/transmitter: PC2-LE-01/PC2-LIT-01

2. Local Control Devices

- a. None

3. Hardwired Interlocks

- a. None

4. Local Process Indicators and Alarms

- a. None

5. MCC Status/Control Functions:

- a. Primary Sludge/Scum Pump No. 1 – RUN, FAIL
- b. Primary Sludge/Scum Pump No. 2 – RUN, FAIL

- c. Primary Sludge/Scum Pump No. 1 – Low Pressure Alarm
- d. Primary Sludge/Scum Pump No. 2 – Low Pressure Alarm
- e. Primary Sludge/Scum Pump No. 1 – High Pressure Alarm
- f. Primary Sludge/Scum Pump No. 2 – High Pressure Alarm

D. PLC/SCADA Monitoring and Control Functions

- a. Primary Sludge/Scum Pump No. 1 – RUN, FAIL, in AUTO
- b. Primary Sludge/Scum Pump No. 2 – RUN, FAIL, in AUTO
- c. Primary Sludge/Scum Pump No. 1 – Mode Selector: SLUDGE or SCUM
- d. Primary Sludge/Scum Pump No. 2 – Mode Selector: SLUDGE or SCUM
- e. Primary Sludge/Scum Pump No. 1 – Low Pressure Alarm
- f. Primary Sludge/Scum Pump No. 2 – Low Pressure Alarm
- g. Primary Sludge/Scum Pump No. 1 – High Pressure Alarm
- h. Primary Sludge/Scum Pump No. 2 – High Pressure Alarm
- i. Primary Scum Wet Well Level
- j. Scum Pump 1 Flow
- k. Scum Pump 2 Flow

1. Control

A. Automatic Mode:

1. Sludge/Scum Pumps

When the sludge/scum pump is in the AUTO position and the SCADA selector is in the AUTO position, the sludge/scum pump will operate as the duty pump in one of two operational modes:

- i. **SLUDGE:** When a sludge/scum pump is selected to operate in the SLUDGE mode the pump will operate based on timer set at a tunable time period of 5 minutes ON at a tunable frequency of every 15 minutes. Plant operation staff will be responsible for confirm the pump's valving is configured appropriately for the selected configuration.
- ii. **SCUM:** When a sludge/scum pump is selected to operate in the SCUM mode the pump will operate turn on when the level in the scum wet well rises above a preset high level for 30 seconds. The SCUM pump will turn off when the level in the scum wet well drops below a preset low level. Plant operation staff will be responsible for confirm the pump's valving is configured appropriately for the selected configuration. In the SCUM mode, the solenoid valve in the primary clarifier scum pit, will open 30 seconds before the SCUM pump turns on. The solenoid valve will continue to run for 30 seconds after the SCUM pump turns off.

B. Manual Mode:

1. Sludge/Scum Pumps

Sludge/Scum Pumps will operate according to the HAND-OFF-AUTO selector.

2. The SCADA screen(s) shall display the following variables and status for each piece of equipment:
 - a. Primary Sludge/Scum Pump No. 1 – RUN, FAIL, in AUTO
 - b. Primary Sludge/Scum Pump No. 2 – RUN, FAIL, in AUTO
 - c. Primary Sludge/Scum Pump No. 1 – FLOW
 - d. Primary Sludge/Scum Pump No. 2 – FLOW
 - e. Primary Sludge/Scum Pump No. 1 – Low Pressure Alarm
 - f. Primary Sludge/Scum Pump No. 2 – Low Pressure Alarm
 - g. Primary Sludge/Scum Pump No. 1 – High Pressure Alarm
 - h. Primary Sludge/Scum Pump No. 2 – High Pressure Alarm
 - i. Primary Sludge/Scum Pump No. 1 – Mode (SLUDGE or SCUM)
 - j. Primary Sludge/Scum Pump No. 2 – Mode (SLUDGE or SCUM)
 - k. Primary Scum Wet Well Level
 - l. Pump 1 Flow
 - m. Pump 2 Flow
3. Software Interlocks: None.
4. Trend Variables:
 - a. Sludge/Scum Pump RUN time
 - b. Sludge/Scum Pump starts per hour
5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
 - a. Manual Start/Stop: Yes
 - b. Manual Speed Control: No
 - c. Manual/PLC Selection: No

- A. References:
Drawings: I400-1, I400-2
PLC: LCP (manufacturer supplied) and PLC-HW located in MCC room.

B. Summary Description:

Secondary polishing consists of two rotating disk filters, four filter backwash pumps, and three submersible filter feed pumps. The filters and backwash pumps are controlled by manufacturer supplied local control panels and PLC. The manufacturer LCPs will control filter operation, receive remote commands and generate status and alarm signals. In automatic mode, the filter units will operate based on an ON signal from the filter feed pumps or a RUN signal from SCADA.

Each filter feed pump has a nominal capacity of about 3 mgd at full speed.. The three pumps are identical and will be driven by VFDs.

In dry weather operation the filters will run in series with the 10 micron filter prior to the 5 micron filter. Flow to the filters is limited to 3 mgd by equalization storage which evens out flows to the secondary treatment process during dry weather. Plant operation staff will be responsible for confirming that the pump's valving is configured appropriately for series operation.

One pump will normally span the full range of daily dry weather diurnal flow span of 0.5 to 3.2 mgd to the WWTP.

In wet weather operation the filters will run in parallel, both with 10 micron cloth media. Max flow to the filters is limited to 9 mgd by equalization storage which limits flows to the secondary treatment process during peak wet weather events. Plant operation staff will be responsible for confirming that the pump's valving is configured appropriately for parallel operation.

C. Field Controls and Instrumentations:

1. Instrumentation

- a. Manufacturer supplied Instrumentation - See packaged equipment I/O list
- b. Filter Influent Wet Well – Level Element/Transmitter: FIL-LE-01/FIL-LIT-01
- c. Filter Influent Wet Well – High Level Float Switch: FIL-LSH-01
- d. Filter Influent Wet Well – Low Level Float Switch: FIL-LSL-01 (Software switch)
- e. Filter Influent Wet Well – Low-Low Level Float Switch: FILL-LSLL-01
- f. Filter Feed Pump No. 1 – Moisture Switch High: FIL-PMP1-MSH-01
- g. Filter Feed Pump No. 2 – Moisture Switch High: FIL-PMP2-MSH-01
- h. Filter Feed Pump No. 3 – Moisture Switch High: FIL-PMP3-MSH-01

- i. Filter Feed Pump No. 1 – Temperature Switch High: FIL-PMP1-TSH-01
 - j. Filter Feed Pump No. 2 – Temperature Switch High: FIL-PMP2-TSH-01
 - k. Filter Feed Pump No. 2 – Temperature Switch High: FIL-PMP3-TSH-01
 - l. Filter Feed Pump No. 1 – Discharge Pressure Indicator: FIL-PMP1-PE-01/FIL-PMP1-PI-01
 - m. Filter Feed Pump No. 2 – Discharge Pressure Indicator: FIL-PMP2-PE-01/FIL-PMP2-PI-01
 - n. Filter Feed Pump No. 3 – Discharge Pressure Indicator: FIL-PMP3-PE-01/FIL-PMP3-PI-01
 - o. Filter Feed Pumps Flow Meter: FIL-FE-01/FIL-FIT-01
2. Local Control Devices
- a. Manufacturer supplied LCPs – See packaged equipment I/O list
 - b. E-STOP will be included on the LCP.
 - c. Filter Feed Pump No. 1 – START/STOP, HAND-OFF-AUTO, and with speed increase/decrease pushbuttons
 - d. Filter Feed Pump No. 2 – START/STOP, HAND-OFF-AUTO, and with speed increase/decrease pushbuttons
 - e. Filter Feed Pump No. 3 – START/STOP, HAND-OFF-AUTO, and with speed increase/decrease pushbuttons
3. Hardwired Interlocks
- a. Low low level shut down from backup low low level float (FIL-LSLL-01)
4. Local Process Indicators and Alarms
- a. See packaged equipment I/O list
 - b. Wet Well Level
 - c. Wet Well Low-Low Level Alarm
 - d. Wet Well High Level Alarm
 - e. Filter Feed Pump Flow (instantaneous)
 - f. Pumps RUN, FAIL, Hi Temp, Seal Leak Alarm
5. MCC room Status/Control Functions: None
- D. PLC/SCADA Monitoring and Control Functions (incl. HMI in Electrical Room)
- a. See packaged equipment I/O list
 - b. Filter Feed Pump No. 1 – START/STOP, HAND-OFF-AUTO and with manual speed or automatic control selector
 - c. Filter Feed Pump No. 2 – START/STOP, HAND-OFF-AUTO and with manual speed or automatic control selector
 - d. Filter Feed Pump No. 3 – START/STOP, HAND-OFF-AUTO and with manual speed or automatic control selector
 - e. Filter Feed Pump No. 1 – Discharge Pressure Indicator
 - f. Filter Feed Pump No. 2 – Discharge Pressure Indicator
 - g. Filter Feed Pump No. 3 – Discharge Pressure Indicator
 - h. Filter Feed Pump No. 1 – Discharge High Pressure Alarm
 - i. Filter Feed Pump No. 2 – Discharge High Pressure Alarm

- j. Filter Feed Pump No. 3 – Discharge High Pressure Alarm
- k. Filter Feed Pump Station Mode Selector (When in Automatic): SERIES, PARALLEL
- l. Filter Feed Pump Flow
- m. Wet Well Low-Low Level Alarm
- n. Wet Well Low Level Alarm
- o. Wet Well High Level Alarm

1. Control

A. Automatic Mode:

1. Filter Feed Pumps

When the Filter Feed Pumps are in the REMOTE position and the SCADA selector is in the AUTO position, the Filter Feed Pumps operational sequence shall be as follows:

On rising flow:

- When the wet well level rises past the High level set point (as measured by the Level Indicating Transmitter, initially set at Elevation selectable feet), the pump speed will increase by 10%.
- If the water level remains above the high level set point for some duration (operator set point, initially set at 1 minute), the pump speed will continue to increase by another 10%.
- If the duty pump reaches 100% speed and water continues to rise, the standby pump will start and come up to 60% speed and the duty pump will reduce to the same speed.
- With both pumps in operation, if water continues to rise, the pump speeds will increase uniformly to maintain flow. If both pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%), the third pump will start and come up to 60% speed and the two pumps will reduce to the same speed.
- With three pumps in operation, if water continues to rise, the pump speeds will increase uniformly to maintain flow. If the three pumps rise in speed to be over the maximum pump operating speed set point (initially set at 100%), the "system demand exceeds pump capacity" alarm shall be activated.

On falling flow:

- When the water level falls past the low level set point (as measured by the Level Indicating Transmitter, initially set at Elevation selectable feet), the pump(s) speed will decrease by 10%.

- If three pumps are in operation and they reach a low transition speed set point (initially set at 45%), the last pump on shall drop off line and the remaining pump(s) shall increase to the one pump transition set point (initially set at 80%).
- If one pump is in operation and the pump speed reaches the cutoff speed set point (initially set at 45%) the duty pump will turn off.

2. Filters

When the filters selector is in the AUTO position the filters will begin to run due to any of the following conditions:

- An ON command has been received from SCADA.
- When a filter feed pump is running.

B. Manual Mode:

1. Filter Feed Pumps

Filter feed pumps will operate according to the HAND-OFF-AUTO selector with speed increase/decrease pushbuttons or electronic keypads.

2. Filters

See packaged equipment I/O list.

3. Emergency Stop

When any of the e-stop pushbuttons are pressed the filters will stop immediately, the control power on light will de-energize. To reset, ensure all e-stops are enabled, and press the system reset pushbutton.

- The SCADA screen(s) shall display the following variables and status for each Pump:
 - Filter Feed Pumps – Low Flow Alarm
 - Filter Feed Pumps – VFD Fail Alarm
 - Filter Feed Pump No. 1 – High Motor Temperature Alarm (shut down motor)
 - Filter Feed Pump No. 2 – High Motor Temperature Alarm (shut down motor)
 - Filter Feed Pump No. 3 – High Motor Temperature Alarm (shut down motor)
 - Filter Feed Pump No. 1 – Moisture Intrusion Alarm (shut down motor)
 - Filter Feed Pump No. 2 – Moisture Intrusion Alarm (shut down motor)
 - Filter Feed Pump No. 3 – Moisture Intrusion Alarm (shut down motor)
 - “System Requests Exceed Pump Capacity” (three pumps at 100% [set point] speed)
 - Wet Well Low-Low Level Alarm (either from float or from transmitter)
 - Wet Well High Level Alarm (either from float or from transmitter)
- Software Interlocks:
 - The filter feed pumps shall turn off if a filter alarm is received.

- b. The filter feed pumps shall not operate below the low-low float switch (wired directly to VFD or power supply).
 - c. The filter feed pumps shall not operate if the associated high moisture alarm is active (wired directly to pump power supply).
 - d. The filter feed pumps shall not operate if the associated high temperature alarm is active (wired directly to pump power supply).
- 4. Trend Variables:
 - a. Filter Feed Pump Speed, each
 - b. Wet Well Level
- 5. Operator Functions from SCADA Screens when selector switch in PLC Mode:
 - a. Manual Start/Stop: Yes
 - b. Manual Speed Control: Yes
 - c. Manual/PLC Selection: Yes

CS-500**TRUCK TURNTABLE****A. References:**

Drawings: I100-2
PLC: Vendor Supplied

B. Summary Description:

The truck turntable will be located on top of the equalization basins, next to the headworks and will facilitate truck and equipment turnaround. The turntable will be capable of rotating clockwise or counter-clockwise at two different speeds. A vendor supplied local control panel and remote control will be provided.

C. Field Controls and Instrumentations:**1. Instrumentation**

- a. None

2. Local Control Devices**a. Local Control Panel**

- 1.) Fast/Slow – Selectable switch
- 2.) Clockwise/Counter-Clockwise – Selectable Switch
- 3.) Emergency Stop
- 4.) Main power On/Off

b. Remote Control

- 1.) Clockwise/Counter-Clockwise – Selectable Switch
- 2.) Emergency Stop

3. Hardwired Interlocks

- a. Emergency stop

4. Local Process Indicators and Alarms**a. Local Control Panel**

- 1.) Running
- 2.) Fault
- 3.) Power

b. Remote Control

- 1.) By handheld remote

5. MCC Status/Control Functions:

- a. None

D. PLC/SCADA Monitoring and Control Functions

- a. RUN
- b. FAIL

1. Control

A. Manual Mode:

1. Turntable Operation

Turntable can be operated locally at the local control panel or using the remote control

2. Software Interlocks: None.

3. Trend Variables:

- a. Run time

4. Operator Functions from SCADA Screens when selector switch in PLC Mode:

- a. RUN
- b. Failure Alarm

CS-600**UTILITY WATER PUMP****A. References:**

Drawings: I600-1
PLC: Existing Main Plant PLC

B. Summary Description:

There are three utility pumps pumping water from existing Chlorine Contact tank into a common main header to maintain a pressure setpoint for the 3W water to serve the treatment processes.

C. Field Controls and Instrumentations:**1. Instrumentation**

- a. Pressure Transducer UW-PMP-PIT-01.
- b. Float switches

2. Control Sequence

The utility pumps shall operate in similar manner as the Tertiary Filter pumping system as specified in CS-400 except the followings:

- a. The utility pumps shall operate based on a pressure setpoint.
- b. The pumps shall shut down when a low level in the existing Chlorine Contact tank is detected by the low level float.

CS-700**RECYCLE PUMP STATION****A. References:**

Drawings: I500-1
PLC: Existing PLC-6

B. Summary Description:

There are two recycle pumps pumping water from existing recycle wetwell into headwork box to maintain a level setpoint for the recycle water wetwell to serve the treatment processes.

C. Field Controls and Instrumentations:**1. Instrumentation**

- a. Existing Level Transducer REC-LIT-01.
- b. Float switches

2. Control Sequence

The recycle pumps shall operate in similar manner as the Tertiary Filter pumping system as specified in CS-400 except the followings:

- a. The recycle pumps shall operate based on a level setpoint.
- b. The pumps shall shut down when a low level in the existing recycle water wetwell is detected by the low level float.

END OF SECTION

SMCSD HEADWORKS
Treatment and Wet Weather Flow Upgrade Project

Prepare by: DTN
Engineers, Inc.
Date: March 2017
DTN Project #: 286F

I/O LIST

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	PLC-HW						
	SPIRAL SCREEN CONTROL PANEL	SC-EQP1/2-LCP-01	SC-EQP1-UI				See Packaged Equipment I/O List
	Spiral Screen Gate No. 3	SC-GAT3	SC-GAT3-HS-02	In Remote Mode	DI	E-12	
	Spiral Screen Gate No. 3	SC-GAT3	SC-GAT3-YA-01	Fail	DI	E-12	
	Spiral Screen Gate No. 3	SC-GAT3	SC-GAT3-ZI-01	Position Indication	AI	E-15	
	Spiral Screen Gate No. 3	SC-GAT3	SC-GAT3-ZIC-01	Position Cmd	AO	E-15	
	Spiral Screen Gate No. 6	SC-GAT6	SC-GAT6-HS-02	In Remote Mode	DI	E-12	
	Spiral Screen Gate No. 6	SC-GAT6	SC-GAT6-HS-01	Open	DI	E-12	
	Spiral Screen Gate No. 6	SC-GAT6	SC-GAT6-HS-01	Closed	DI	E-12	
	Spiral Screen Gate No. 6	SC-GAT6	SC-GAT6-YA-01	Overload	DI	E-12	
	Spiral Screen Gate No. 6	SC-GAT6	SC-GAT6-ZSH-01	Open Cmd	DO	E-14	
	Spiral Screen Gate No. 6	SC-GAT6	SC-GAT6-ZSL-01	Close Cmd	DO	E-14	
	Equalization Gate No. 1	EQ-GAT1	EQ-GAT1-ZS-01	Open Ind	DI	E-12	
	Equalization Gate No. 1	EQ-GAT1	EQ-GAT1-ZS-01	Close Ind	DI	E-12	
	Equalization Gate No. 2	EQ-GAT2	EQ-GAT2-ZS-01	Open Ind	DI	E-12	
	Equalization Gate No. 2	EQ-GAT2	EQ-GAT2-ZS-01	Close Ind	DI	E-12	
	Equalization Gate No. 3	EQ-GAT3	EQ-GAT3-HS-02	In Remote Mode	DI	E-12	
	Equalization Gate No. 3	EQ-GAT3	EQ-GAT3-YA-02	Fail	DI	E-12	
	Equalization Gate No. 3	EQ-GAT3	EQ-GAT3-ZL-01	Position Indication	AI	E-15	
	Equalization Gate No. 3	EQ-GAT3	EQ-GAT3-ZIC-01	Position Cmd	AO	E-15	
	EQ Return - Gate No. 1	EQ-GAT4	EQ-GAT4-ZS-01	Open Ind	DI	E-13	
	EQ Return - Gate No. 1	EQ-GAT4	EQ-GAT4-ZS-01	Close Ind	DI	E-13	

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	EQ Return - Gate No. 2	EQ-GAT5	EQ-GAT5-ZS-01	Open Ind	DI	E-13	
	EQ Return - Gate No. 2	EQ-GAT5	EQ-GAT5-ZS-01	Close Ind	DI	E-13	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-HS-01	In Auto Mode	DI	E-12	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-HS-01	Run	DI	E-12	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-YA-01	Fail	DI	E-12	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-PAH-01	High Press Alarm	DI	E-12	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-PAL-01	Low Press Alarm	DI	E-12	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-HS-01	Start/Stop Cmd	DO	E-14	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-SI-01	Speed Indication	AI	E-15	
	Equalization Pump No. 1	EQ-PMP1	EQ-PMP1-SIC-01	Speed Cmd	AO	E-15	
	EQ Pump No. 1 Press Transmitter	EQ-PMP1-PIT	EQ-PMP1-PIT-01	Pressure Indication	AI	E-15	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-HS-01	In Auto Mode	DI	E-12	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-HS-01	Run	DI	E-12	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-YA-01	Fail	DI	E-12	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-PAH-01	High Press Alarm	DI	E-12	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-PAL-01	Low Press Alarm	DI	E-12	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-HS-01	Start/Stop Cmd	DO	E-14	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-SI-01	Speed Indication	AI	E-15	
	Equalization Pump No. 2	EQ-PMP2	EQ-PMP2-SIC-01	Speed Cmd	AO	E-15	
	EQ Pump No. 2 Press Transmitter	EQ-PMP2-PIT	EQ-PMP2-PIT-01	Pressure Indication	AI	E-15	
	Grit Pump No. 1	GRT-PMP1	GRT-PMP1-HS-02	In Auto Mode	DI	E-12	
	Grit Pump No. 1	GRT-PMP1	GRT-PMP1-HS-01	Run	DI	E-12	
	Grit Pump No. 1	GRT-PMP1	GRT-PMP1-YA-01	Fail	DI	E-12	
	Grit Pump No. 1	GRT-PMP1	GRT-PMP1-ZSL-01	No Flow	DI	E-12	
	Grit Pump No. 1	GRT-PMP1	GRT-PMP1-PAH-01	Hi Press Alarm	DI	E-12	
	Grit Pump No. 1	GRT-PMP1	GRT-PMP1-HS-01	Start/Stop Cmd	DO	E-14	
	Grit Pump No. 2	GRT-PMP2	GRT-PMP2-HS-02	In Auto Mode	DI	E-12	
	Grit Pump No. 2	GRT-PMP2	GRT-PMP2-HS-01	Run	DI	E-12	
	Grit Pump No. 2	GRT-PMP2	GRT-PMP2-YA-01	Fail	DI	E-12	
	Grit Pump No. 2	GRT-PMP2	GRT-PMP2-ZSL-01	No Flow	DI	E-12	
	Grit Pump No. 2	GRT-PMP2	GRT-PMP2-PAH-01	Hi Press Alarm	DI	E-12	

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Grit Pump No. 2	GRT-PMP2	GRT-PMP2-HS-01	Start/Stop Cmd	DO	E-14	
	GRIT WASHER CONTROL PANEL	GC-EQP1-LCP-01	GC-EQP1-UI				See Packaged Equipment I/O List
	Equalization Pump 1 Plug Valve No. 1	EQ-PMP1-PVLV10-01	EQ-PMP1-PVLV10-01-HS-01	In Remote Mode	DI	E-13	
	Equalization Pump 1 Plug Valve No. 1	EQ-PMP1-PVLV10-01	EQ-PMP1-PVLV10-01-HS-02	Open	DI	E-13	
	Equalization Pump 1 Plug Valve No. 1	EQ-PMP1-PVLV10-01	EQ-PMP1-PVLV10-01-HS-02	Closed	DI	E-13	
	Equalization Pump 1 Plug Valve No. 1	EQ-PMP1-PVLV10-01	EQ-PMP1-PVLV10-01-YA-01	Overload	DI	E-13	
	Equalization Pump 1 Plug Valve No. 1	EQ-PMP1-PVLV10-01	EQ-PMP1-PVLV10-01-ZSH-01	Open Cmd	DO	E-14	
	Equalization Pump 1 Plug Valve No. 1	EQ-PMP1-PVLV10-01	EQ-PMP1-PVLV10-01-ZSL-01	Close Cmd	DO	E-14	
	Equalization Pump 1 Plug Valve No. 2	EQ-PMP1-PVLV10-02	EQ-PMP1-PVLV10-02-HS-01	In Remote Mode	DI	E-13	
	Equalization Pump 1 Plug Valve No. 2	EQ-PMP1-PVLV10-02	EQ-PMP1-PVLV10-02-HS-02	Open	DI	E-13	
	Equalization Pump 1 Plug Valve No. 2	EQ-PMP1-PVLV10-02	EQ-PMP1-PVLV10-02-HS-02	Closed	DI	E-13	
	Equalization Pump 1 Plug Valve No. 2	EQ-PMP1-PVLV10-02	EQ-PMP1-PVLV10-02-YA-01	Overload	DI	E-13	
	Equalization Pump 1 Plug Valve No. 2	EQ-PMP1-PVLV10-02	EQ-PMP1-PVLV10-02-ZSH-01	Open Cmd	DO	E-14	
	Equalization Pump 1 Plug Valve No. 2	EQ-PMP1-PVLV10-02	EQ-PMP1-PVLV10-02-ZSL-01	Close Cmd	DO	E-14	

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Equalization Pump 2 Plug Valve No. 1	EQ-PMP2-PVLV10-01	EQ-PMP2-PVLV10-01-HS-01	In Remote Mode	DI	E-13	
	Equalization Pump 2 Plug Valve No. 1	EQ-PMP2-PVLV10-01	EQ-PMP2-PVLV10-01-HS-02	Open	DI	E-13	
	Equalization Pump 2 Plug Valve No. 1	EQ-PMP2-PVLV10-01	EQ-PMP2-PVLV10-01-HS-02	Closed	DI	E-13	
	Equalization Pump 2 Plug Valve No. 1	EQ-PMP2-PVLV10-01	EQ-PMP2-PVLV10-01-YA-01	Overload	DI	E-13	
	Equalization Pump 2 Plug Valve No. 1	EQ-PMP2-PVLV10-01	EQ-PMP2-PVLV10-01-ZSH-01	Open Cmd	DO	E-14	
	Equalization Pump 2 Plug Valve No. 1	EQ-PMP2-PVLV10-01	EQ-PMP2-PVLV10-01-ZSL-01	Close Cmd	DO	E-14	
	Equalization Pump 2 Plug Valve No. 2	EQ-PMP2-PVLV10-02	EQ-PMP2-PVLV10-02-HS-01	In Remote Mode	DI	E-13	
	Equalization Pump 2 Plug Valve No. 2	EQ-PMP2-PVLV10-02	EQ-PMP2-PVLV10-02-HS-02	Open	DI	E-13	
	Equalization Pump 2 Plug Valve No. 2	EQ-PMP2-PVLV10-02	EQ-PMP2-PVLV10-02-HS-02	Closed	DI	E-13	
	Equalization Pump 2 Plug Valve No. 2	EQ-PMP2-PVLV10-02	EQ-PMP2-PVLV10-02-YA-01	Overload	DI	E-13	
	Equalization Pump 2 Plug Valve No. 2	EQ-PMP2-PVLV10-02	EQ-PMP2-PVLV10-02-ZSH-01	Open Cmd	DO	E-14	
	Equalization Pump 2 Plug Valve No. 2	EQ-PMP2-PVLV10-02	EQ-PMP2-PVLV10-02-ZSL-01	Close Cmd	DO	E-14	
	Equalization Plug Valve No. 4	EQ-PVLV10-04	EQ-PVLV10-04-HS-01	In Remote Mode	DI	E-13	
	Equalization Plug Valve No. 4	EQ-PVLV10-04	EQ-PVLV10-04-HS-02	Open	DI	E-13	
	Equalization Plug Valve No. 4	EQ-PVLV10-04	EQ-PVLV10-04-HS-02	Closed	DI	E-13	
	Equalization Plug Valve No. 4	EQ-PVLV10-04	EQ-PVLV10-04-YA-01	Overload	DI	E-13	
	Equalization Plug Valve No. 4	EQ-PVLV10-04	EQ-PVLV10-04-ZSH-01	Open Cmd	DO	E-14	
	Equalization Plug Valve No. 4	EQ-PVLV10-04	EQ-PVLV10-04-ZSL-01	Close Cmd	DO	E-14	
	Equalization Plug Valve No. 5	EQ-PVLV10-05	EQ-PVLV10-05-HS-01	In Remote Mode	DI	E-13	
	Equalization Plug Valve No. 5	EQ-PVLV10-05	EQ-PVLV10-05-HS-02	Open	DI	E-13	
	Equalization Plug Valve No. 5	EQ-PVLV10-05	EQ-PVLV10-05-HS-02	Closed	DI	E-13	
	Equalization Plug Valve No. 5	EQ-PVLV10-05	EQ-PVLV10-05-YA-01	Overload	DI	E-13	
	Equalization Plug Valve No. 5	EQ-PVLV10-05	EQ-PVLV10-05-ZSH-01	Open Cmd	DO	E-14	

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Equalization Plug Valve No. 5	EQ-PVLV10-05	EQ-PVLV10-05-ZSL-01	Close Cmd	DO	E-14	
	Turntable	MHA-HEQP	MHA-EQP1-HS-01	Run	DI	E-13	
	Turntable	MHA-HEQP	MHA-EQP1-YA-01	Fail	DI	E-13	
	Ventilation Unit	HW-EXF1	HW-EXF1-HS-02	In Auto Mode	DI	E-13	
	Ventilation Unit	HW-EXF1	HW-EXF1-HS-01	Run	DI	E-13	
	Ventilation Unit	HW-EXF1	HW-EXF1-YA-01	Fail	DI	E-13	
	PRIMARY CLARIFIER No. 2 CONTROL PANEL	PC2-DRV1-LCP-01	PC2-DRV1-UI				See Packaged Equipment I/O List
	Primary Sludge Pump No. 1	PC2-PMP1	PC2-PMP1-HS-02	In Auto Mode	DI	E-13	
	Primary Sludge Pump No. 1	PC2-PMP1	PC2-PMP1-HS-01	Run	DI	E-13	
	Primary Sludge Pump No. 1	PC2-PMP1	PC2-PMP1-YA-01	RVSS Fail	DI	E-13	
	Primary Sludge Pump No. 1	PC2-PMP1	PC2-PMP1-PSH-01	High Press Alarm	DI	E-13	
	Primary Sludge Pump No. 1	PC2-PMP1	PC2-PMP1-PSL-01	Low Press Alarm	DI	E-13	
	Primary Sludge Pump No. 1	PC2-PMP1	PC2-PMP1-HS-01	Run Cmd	DO	E-14	
	Primary Sludge Pump No. 2	PC2-PMP2	PC2-PMP2-HS-02	In Auto Mode	DI	E-13	
	Primary Sludge Pump No. 2	PC2-PMP2	PC2-PMP2-HS-01	Run	DI	E-13	
	Primary Sludge Pump No. 2	PC2-PMP2	PC2-PMP2-YA-01	RVSS Fail	DI	E-13	
	Primary Sludge Pump No. 2	PC2-PMP2	PC2-PMP2-PSH-01	High Press Alarm	DI	E-13	
	Primary Sludge Pump No. 2	PC2-PMP2	PC2-PMP2-PSL-01	Low Press Alarm	DI	E-13	
	Primary Sludge Pump No. 2	PC2-PMP2	PC2-PMP2-HS-01	Run Cmd	DO	E-14	
	EQ Basin 1	EQ1-LSHH	EQ1-LSHH-01	Hi Level Alarm	DI	E-13	
	EQ Basin 2	EQ2-LSHH	EQ2-LSHH-01	Hi Level Alarm	DI	E-13	
	Scum Pit	PC2-LSLL	PC2-LSLL-01	Low Level Alarm	DI	E-13	
	Scum Pump 1 Flow Transmitter	PC1-PMP1-FIT	PC1-PMP1-FIT-01	Flow Indication	AI	E-15	
	Scum Pump 2 Flow Transmitter	PC2-PMP2-FIT	PC2-PMP2-FIT-01	Flow Indication	AI	E-15	
	EQ Pumping Flow Transmitter	EQ-FIT	EQ-FIT-01	Flow Indication	AI	E-15	
	EQ Basin 1 Level Transmitter	EQ1-LIT	EQ1-LIT-01	Level Indication	AI	E-15	
	EQ Basin 2 Level Transmitter	EQ2-LIT	EQ2-LIT-01	Level Indication	AI	E-15	

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Parshall Flume Level Transmitter 1	FLW1-LIT-01	FLW1-LIT-01	Level Indication	AI	E-15	
	Parshall Flume Level Transmitter 2	FLW1-LIT-02	FLW1-LIT-02	Level Indication	AI	E-15	
	Grit System No. 3W SV	GRT-SVLV01	GRT-SVLV01-01	Open/Close Cmd	DO	E-14	
	EQ Basin 1 No. 3W	EQ1-SVLV01	EQ1-SVLV01-01	Open/Close Cmd	DO	E-14	
	EQ Basin 1 No. 3W	EQ1-TRS1-SVLV01	EQ1-TRS1-SVLV01-01	Open/Close Cmd	DO	E-14	
	EQ Basin 2 No. 3W	EQ2-SVLV01	EQ2-SVLV01-01	Open/Close Cmd	DO	E-14	
	EQ Basin 2 No. 3W	EQ2-TRS1-SVLV02	EQ2-TRS1-SVLV02-01	Open/Close Cmd	DO	E-14	
	EQ Basin 2 No. 3W	EQ2-TRS2-SVLV01	EQ2-TRS2-SVLV01-01	Open/Close Cmd	DO	E-14	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-HS-02	In Auto Mode	DI	E-7	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-HS-01	Run	DI	E-7	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-YA-01	Fail	DI	E-7	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-MSH-01	Leak Alarm	DI	E-7	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-HS-01	Start/Stop Cmd	DI	E-7	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-SI-01	Speed Indication	AI	E-7	
	Ferric Chloride Metering Pump	FC-PMP1	FC-PMP1-SIC-01	Speed Cmd	AO	E-7	
	Ferric Chloride Tank	FC-TNK1	FS-TNK1-LSH-01	Hi Level Alarm	DI	E-7	
	Ferric Chloride Tank	FC-TNK1	FS-TNK1-LSHH-01	Hi Hi Level Alarm	DI	E-7	
	Ferric Chloride Tank	FC-TNK1	FS-TNK1-LSL-01	Low Level Alarm	DI	E-7	
	Ferric Chloride Tank	FC-TNK1	FC-TNK1-LIT-01	Level Ind	AI	E-7	
	Auto Refrigerated Sampler	HW-EQP1	HW-EQP1-YA-01	Fail	DI	E-7	
	Auto Refrigerated Sampler	HW-EQP1	HW-EQP1-FIC-01	Plant Flow Ind	AI	E-7	
	Emergency Eyewash	FC-SHWR1	FC-SHWR1-FSH-01	Eyewash Activate	DI	E-13	
	Fire Alarm Control Panel	HW-FIRE		Trouble	DI	E-21	
	Fire Alarm Control Panel	HW-FIRE		Fire Alarm	DI	E-21	
	PLC-GEN						

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-HS-02	In Auto Mode	DI	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-HS-01	Run	DI	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-YA-01	VFD Fail	DI	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-TSH-01	Hi Temp Alarm	DI	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-MSH-01	Seal Leak Alarm	DI	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-HS-01	Start/Stop Cmd	DO	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-SI-01	Speed Ind	AI	E-16	
	Filter Feed Pump No. 1	FIL-PMP1	FIL-PMP1-SIC-01	Speed Cmd	AO	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-HS-02	In Auto Mode	DI	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-HS-01	Run	DI	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-YA-01	VFD Fail	DI	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-TSH-01	Hi Temp Alarm	DI	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-MSH-01	Seal Leak Alarm	DI	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-HS-01	Start/Stop Cmd	DO	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-SI-01	Speed Ind	AI	E-16	
	Filter Feed Pump No. 2	FIL-PMP2	FIL-PMP2-SIC-01	Speed Cmd	AO	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-HS-02	In Auto Mode	DI	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-HS-01	Run	DI	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-YA-01	VFD Fail	DI	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-TSH-01	Hi Temp Alarm	DI	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-MSH-01	Seal Leak Alarm	DI	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-HS-01	Start/Stop Cmd	DO	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-SI-01	Speed Ind	AI	E-16	
	Filter Feed Pump No. 3	FIL-PMP3	FIL-PMP3-SIC-01	Speed Cmd	AO	E-16	
	FILTER 1 BACKWASH CONTROL PANEL	FIL1-EQP1-LCP-01					See Packaged Equipment I/O List
	FILTER 2 BACKWASH CONTROL PANEL	FIL2-EQP2-LCP-02					See Packaged Equipment I/O List
	Filter Influent	FIL-LSLL	FIL-LSLL-01	Low Level Alarm	DI	E-16	
	Filter Influent	FIL-LSH	FIL-LSH-01	High Level Alarm	DI	E-16	
	Filter Influent	FIL-LIT	FIL-LIT-01	Level Indication	AI	E-16	
	Filter Influent	FIL-FIT	FIL-FIT-01	Flow Indication	AI	E-16	

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SMCSD HEADWORKS
Treatment and Wet Weather Flow Upgrade Project

13481 Packaged Equipment I/O LIST

Prepare by: DTN
Engineers, Inc.
Date: March 2017
DTN Project #: 286F

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	SPIRAL SCREEN CONTROL PANEL	SC-EQP1/2-LCP-01				I100-1	
	Screening Screw 1			Run			Virtual Point
	Screening Screw 1			Fail			Virtual Point
	Screening Screw 1			In Auto			Virtual Point
	Screening Screw 2			Run			Virtual Point
	Screening Screw 2			Fail			Virtual Point
	Screening Screw 2			In Auto			Virtual Point
	Screening Conveyor			Run			Virtual Point
	Screening Conveyor			Fail			Virtual Point
	Screening Conveyor			In Auto			Virtual Point
	Screening 1 Water Valve 1			Open			Virtual Point
	Screening 1 Water Valve 1			Closed			Virtual Point
	Screening 1 Water Valve 2			Open			Virtual Point
	Screening 1 Water Valve 2			Closed			Virtual Point
	Screening 1 Water Valve 3			Open			Virtual Point
	Screening 1 Water Valve 3			Closed			Virtual Point
	Screening 2 Water Valve 1			Open			Virtual Point
	Screening 2 Water Valve 1			Closed			Virtual Point
	Screening 2 Water Valve 2			Open			Virtual Point
	Screening 2 Water Valve 2			Closed			Virtual Point
	Screening 2 Water Valve 3			Open			Virtual Point
	Screening 2 Water Valve 3			Closed			Virtual Point
	Screening Level 1 Transmitter 1			Level Indication			Virtual Point
	Screening Level 2 Transmitter 1			Level Indication			Virtual Point

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	GRIT WASHER CONTROL PANEL	GC-EQP1-LCP-01				I100-3	
	Grit Washer Mixer			Run			Virtual Point
	Grit Washer Mixer			Fail			Virtual Point
	Grit Washer Mixer			In Auto			Virtual Point
	Grit Washer Screw			Run			Virtual Point
	Grit Washer Screw			Fail			Virtual Point
	Grit Washer Screw			In Auto			Virtual Point
	Grit Washer MOV			Fail			Virtual Point
	Grit Washer MOV			In Auto			Virtual Point
	Grit Washer MOV			Open			Virtual Point
	Grit Washer MOV			Closed			Virtual Point
	PRIMARY CLARIFIER No. 2 CONTROL PANEL	PC2-DRV1-LCP-01				I200-1	
	Primary Clarifier No. 2			Run			See PLC I/O List
	Primary Clarifier No. 2			Fail (Overload)			See PLC I/O List
	Primary Clarifier No. 2			In Auto			See PLC I/O List
	Primary Clarifier No. 2			Alarm (Hi Torque)			See PLC I/O List
	Primary Clarifier No. 2			Shut Down (Hi Hi Torque)			See PLC I/O List
	Primary Clarifier No. 2			Start/Stop Comd			See PLC I/O List
	FILTER 1 BACKWASH CONTROL PANEL	FIL1-EQP1-LCP-01				I400-1	
	Filter 1 Backwash Pump No. 1			Run			Virtual Point
	Filter 1 Backwash Pump No. 1			Fail			Virtual Point
	Filter 1 Backwash Pump No. 1			In Auto			Virtual Point

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Filter 1 Backwash Pump No. 2			Run			Virtual Point
	Filter 1 Backwash Pump No. 2			Fail			Virtual Point
	Filter 1 Backwash Pump No. 2			In Auto			Virtual Point
	Filter 1 Motorized Inlet Gate			Open			Virtual Point
	Filter 1 Motorized Inlet Gate			Closed			
	Filter 1 Motorized Inlet Gate			Fail			Virtual Point
	Filter 1 Motorized Inlet Gate			In Auto			Virtual Point
	Filter 1 Level Transmitter			Level Indication			Virtual Point
	Filter 1 Analyzer 1			Influent Turbidity Indication			Virtual Point
	Filter 1 Analyzer 2			Effluent Turbidity Indication			Virtual Point
	Filter 1 High Level Float			Hi Level Alarm			Virtual Point
	Filter 1 Backwash Pump 1 Valve 1			Open			Virtual Point
	Filter 1 Backwash Pump 1 Valve 1			Closed			Virtual Point
	Filter 1 Backwash Pump 1 Valve 1			Fail			Virtual Point
	Filter 1 Backwash Pump 1 Valve 1			In Auto			Virtual Point
	Filter 1 Backwash Pump 1 Valve 2			Open			Virtual Point
	Filter 1 Backwash Pump 1 Valve 2			Closed			Virtual Point
	Filter 1 Backwash Pump 1 Valve 2			Fail			Virtual Point
	Filter 1 Backwash Pump 1 Valve 2			In Auto			Virtual Point
	Filter 1 Backwash Pump 1 Valve 3			Open			Virtual Point
	Filter 1 Backwash Pump 1 Valve 3			Closed			Virtual Point
	Filter 1 Backwash Pump 1 Valve 3			Fail			Virtual Point
	Filter 1 Backwash Pump 1 Valve 3			In Auto			Virtual Point
	Filter 1 Backwash Pump 2 Valve 1			Open			Virtual Point
	Filter 1 Backwash Pump 2 Valve 1			Closed			Virtual Point
	Filter 1 Backwash Pump 2 Valve 1			Fail			Virtual Point

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Filter 1 Backwash Pump 2 Valve 1			In Auto			Virtual Point
	Filter 1 Backwash Pump 2 Valve 2			Open			Virtual Point
	Filter 1 Backwash Pump 2 Valve 2			Closed			Virtual Point
	Filter 1 Backwash Pump 2 Valve 2			Fail			Virtual Point
	Filter 1 Backwash Pump 2 Valve 2			In Auto			Virtual Point
	FILTER 2 BACKWASH CONTROL PANEL	FIL2-EQP2-LCP-02				I400-1	
	Filter 2 Backwash Pump No. 1			Run			Virtual Point
	Filter 2 Backwash Pump No. 1			Fail			Virtual Point
	Filter 2 Backwash Pump No. 1			In Auto			Virtual Point
	Filter 2 Backwash Pump No. 2			Run			Virtual Point
	Filter 2 Backwash Pump No. 2			Fail			Virtual Point
	Filter 2 Backwash Pump No. 2			In Auto			Virtual Point
	Filter 2 Motorized Inlet Gate			Open			Virtual Point
	Filter 2 Motorized Inlet Gate			Closed			
	Filter 2 Motorized Inlet Gate			Fail			Virtual Point
	Filter 2 Motorized Inlet Gate			In Auto			Virtual Point
	Filter 2 Level Transmitter			Level Indication			Virtual Point
	Filter 2 Analyzer 1			Influent Turbidity Indication			Virtual Point
	Filter 2 Analyzer 2			Effluent Turbidity Indication			Virtual Point
	Filter 2 High Level Float			Hi Level Alarm			Virtual Point
	Filter 2 Backwash Pump 1 Valve 1			Open			Virtual Point
	Filter 2 Backwash Pump 1 Valve 1			Closed			Virtual Point
	Filter 2 Backwash Pump 1 Valve 1			Fail			Virtual Point
	Filter 2 Backwash Pump 1 Valve 1			In Auto			Virtual Point

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. No.	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Filter 2 Backwash Pump 1 Valve 2			Open			Virtual Point
	Filter 2 Backwash Pump 1 Valve 2			Closed			Virtual Point
	Filter 2 Backwash Pump 1 Valve 2			Fail			Virtual Point
	Filter 2 Backwash Pump 1 Valve 2			In Auto			Virtual Point
	Filter 2 Backwash Pump 1 Valve 3			Open			Virtual Point
	Filter 2 Backwash Pump 1 Valve 3			Closed			Virtual Point
	Filter 2 Backwash Pump 1 Valve 3			Fail			Virtual Point
	Filter 2 Backwash Pump 1 Valve 3			In Auto			Virtual Point
	Filter 2 Backwash Pump 2 Valve 1			Open			Virtual Point
	Filter 2 Backwash Pump 2 Valve 1			Closed			Virtual Point
	Filter 2 Backwash Pump 2 Valve 1			Fail			Virtual Point
	Filter 2 Backwash Pump 2 Valve 1			In Auto			Virtual Point
	Filter 2 Backwash Pump 2 Valve 2			Open			Virtual Point
	Filter 2 Backwash Pump 2 Valve 2			Closed			Virtual Point
	Filter 2 Backwash Pump 2 Valve 2			Fail			Virtual Point
	Filter 2 Backwash Pump 2 Valve 2			In Auto			Virtual Point

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Prepare by: DTN Engineers, Inc.

Primary and Secondary Treatment Project

Date: March 2017

INSTRUMENT INDEX

DTN Project #: 286F

The Contractor shall coordinate with the Engineer during shop drawing submittal stage regarding proper and required instruments' ranges and set points.

Item	INSTRUMENTS DESCRIPTION	AREA	NAME	LOOP No.	RANGE	SET POINT	SPECS	DWG No.	NOTES
	Influent Screening Equipment 1 Level Transmitter 1	SC-EQP1	LIT	01				I100-1	
	Influent Screening Equipment 2 Level Transmitter 1	SC-EQP2	LIT	01				I100-1	
	Headwork Parshall Flume Level Transmitter 1	HW-FLW1	LIT	01				I100-1	
	Headwork Parshall Flume Level Transmitter 2	HW-FLW1	LIT	02				I100-1	
	Equalization Storage Basin No. 1 Level Transmitter	EQ1	LIT	01				I100-4	
	Equalization Storage Basin No. 1 Level Switch Hi Hi	EQ1	LSHH	01				I100-4	
	Equalization Storage Basin No. 2 Level Transmitter	EQ2	LIT	01				I100-4	
	Equalization Storage Basin No. 2 Level Switch Hi Hi	EQ2	LSHH	01				I100-4	
	Equalization Flow Transmitter	EQ-PVLV10	FIT	01				I100-4	
	Ferric Chloride Storage Tank Level Transmitter	FC-TNK1	LIT	01				I100-5	
	Ferric Chloride Drainage Sump Level Switch Hi	FC	LSH	01				I100-5	
	Ferric Chloride Emergency Eyewash Flow Switch Hi	FC-SHWR1	FSH	01				I100-5	
	Diesel Fuel Tank Level Transmitter	FUEL-TNK	LIT	01				I100-5	
	Diesel Fuel Tank Level Switch Hi Hi	FUEL-TNK	LSHH	01				I100-5	
	Diesel Fuel Tank Emergency Eyewash Flow Switch Hi	FUEL-SHWR1	FSH	01				I100-5	
	Primary Clarifier 2 Level Transmitter	PC2	LIT	01				I200-1	

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INSTRUMENT INDEX

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Item	INSTRUMENTS DESCRIPTION	AREA	NAME	LOOP No.	RANGE	SET POINT	SPECS	DWG No.	NOTES
	Primary Clarifier 2 Level Switch Lo Lo	PC2	LSLL	01				I200-1	
	Primary Clarifier 2 Pump 1 Flow Transmitter	PC2-PMP1	FIT	01				I200-1	
	Primary Clarifier 2 Pump 2 Flow Transmitter	PC2-PMP2	FIT	01				I200-1	
	Filter Pump Station Wet Well Level Transmitter	FIL	LIT	01				I400-1	
	Filter Pump Station Wet Well Level Switch Lo	FIL	LSL	01				I400-1	
	Filter Pump Station Wet Well Level Switch Lo Lo	FIL	LSLL	01				I400-1	
	Filter Pump Station Wet Well Level Switch Hi	FIL	LSH	01				I400-1	
	Filter Pump Station Wet Well Level Switch Hi Hi	FIL	LSHH	01				I400-1	
	Filter Pump Station Wet Well Flow Transmitter	FIL	FIT	01				I400-1	
	Filter Backwash 1 Analyzer Transmitter 1	FIL1-EQP1	AIT	01				I400-2	
	Filter Backwash 1 Analyzer Transmitter 2	FIL1-EQP1	AIT	02				I400-2	
	Filter Backwash 1 Level Transmitter 1	FIL1-EQP1	LIT	01				I400-2	
	Filter Backwash 1 Level Switch Hi Hi	FIL1-EQP1	LSHH	01				I400-2	
	Filter Backwash 2 Analyzer Transmitter 2	FIL2-EQP2	AIT	02				I400-2	
	Filter Backwash 2 Level Transmitter 1	FIL2-EQP2	LIT	01				I400-2	
	Filter Backwash 2 Level Switch Hi Hi	FIL2-EQP2	LSHH	01				I400-2	

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INSTRUMENT INDEX

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The Contractor shall coordinate with the Engineer during shop drawing submittal stage regarding proper and required instruments' ranges and set points.

Item	INSTRUMENTS DESCRIPTION	AREA	NAME	LOOP No.	RANGE	SET POINT	SPECS	DWG No.	NOTES
	Recycle Pump Station Existing Level Transmitter	REC	LIT	01				I500-1	
	Recycle Pump Station Level Switch Hi	REC	LSH	01				I500-1	
	Recycle Pump Station Level Switch Lo Lo	REC	LSLL	01				I500-1	
	Utility Water Pump Station Level Switch Hi	UW	LSH	01				I600-1	
	Utility Water Pump Station Level Switch Lo Lo	UW	LSLL	01				I600-1	
	Utility Water Pump Station Pressure Transmitter	UW-PMP	PIT	01				I600-1	

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SECTION 14510 – SHAFTLESS SCREW CONVEYORS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install all tools, supplies, materials, equipment and labor necessary for the installation, testing, and placing into operation one shaftless screw conveyor and appurtenances, complete and operable, all in accordance with the requirements of the Contract Documents. Material conveyed is screened material from the headworks.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSL
- E. NFPA
- F. CEMA
- G. AGMA
- H. IEEE
- I. NEMA

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300, CONTRACTOR shall submit the following:
 - 1. Structural calculations for conveyor supports
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01730 - Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 0.5 person-days for installation assistance and inspection,
2. 1 person-days for functional and performance testing
3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – SC-CON1

- A. The conveyor shall consist of a horizontal shaftless screw conveyor complete with drive, torque overload relay, Brinell 250 min., 85,000 min yield strength alloy steel cold formed spiral, stainless trough and UHMWPE liner. The conveyor out-load system shall deposit screenings directly into the dumpster.
- B. The conveyor shall be sized and designed to convey up to 10 cubic feet per hour of screenings at a solids content of 15 to 25 percent by weight. Typical bulk density for screenings is approximately 40-60 lbs per cubic foot. Maximum design loading shall be at 50 percent of trough filling.

- C. Conveyor shall have a stainless steel trough and chutes to guide the sludge from the screen to the shaftless screw conveyor and from the conveyor to the dumpster.
- D. The CONTRACTOR shall be responsible to ensure the conveyor and filter screen manufacturers work together to design the discharge chute to convey screenings from the filter screens into the conveyor. It is the conveyor manufacturer's responsibility to provide the chute.

2.2 PERFORMANCE REQUIREMENTS

- A. The conveyor shall be sized to convey the design material handling rate at less than 30 percent of the conveyor's rated capacity and 35 percent trough filling. The conveyor drive unit shall be designed for 100 percent of rated capacity.
- B. Manufacturer shall demonstrate by submission of calculations that at its torsional rating, the stress in the extreme fiber of the auger flighting does not exceed 30 percent of the F_y value of the flight material. Manufacturer shall also demonstrate that at 250 percent of the motor nameplate horsepower, the drive unit cannot produce more torque than the torsional rating of the flighting.
- C. Conveyor operation shall not cause excessive noise or vibration under all loading conditions. The conveyor, including drive unit, shall be designed such that noise levels in normal operation will not exceed 80 dBA at 3 feet from the equipment.

2.3 MATERIALS OF CONSTRUCTION

- A. Unless otherwise specified or permitted, the materials used in the fabrication of the equipment furnished under this section shall conform to the following:

Trough, chutes, covers, and drive and end plates	Type 316 stainless steel, acid passivated
Spiral flights	Hot rolled and Cold-formed high strength micro-alloy steel, with 250 Brinell minimum and 85,000 psi yield minimum
Wear liner	UHMW elastomer, 3/8-inch minimum thickness with antiwear filler and synthetic lubricant.
Supports	316 stainless steel, acid passivated
Bolts, nuts, and washers for conveyor supports, and in contact with sludge	Type 316L stainless steel. All threads shall be coated with "never seize" or equal.

B. Spiral Flighting

1. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft. The spiral flights shall be designed with the stability to prevent distortion and jumping in the trough. The spiral flighting shall be formed in sections from one continuous flat bar. Sectional flighting formed from plate shall not be permitted. The minimum flight thickness and height for the

primary spiral shall be 3/4-inch (20 mm) and 2.0-inch (50 mm) respectively. An integral secondary inner spiral welded to the primary spiral shall have thickness and width of 0.5-inch (12 mm) x 1.2-inch (30 mm) respectively. Single spirals of any width are not acceptable.

2. Spiral flighting shall have full penetration welds (minimum of six weld passes) at all splice connections. The flights shall be fabricated and welded on a jig to assure true alignment and shall be assembled according to the manufacturer's recommendations. The spiral flights shall be coupled to the end shafts by a pipe to shaft connection of sufficient strength to transmit thrust and/or torsion applicable to meet performance criteria.

C. End Shaft Connections

1. The spiral flighting shall be connected to the drive shaft by welding the spirals to a 3.4-inch minimum circular torque plate properly reinforced with a curved gusset plate for 180 degrees. A separate connection plate shall be bored with a hole equal to the shaft and the drive shaft shall be concentrically welded to the plate to effectively transmit torque and bolted to the torque plate. Spiral connections shall be welded according to AISC B-U3-GF (double V groove) and be full penetration welds. Flights shall be welded in a jig to assure true alignment.

D. Troughs and Chutes

1. Troughs shall conform to the dimensional standards of CEMA 300 and enclosure classification IIIE. Each conveyor trough shall be fabricated from a minimum 1/8-inch plate. Each trough shall be equipped with filling and/or discharge chutes locations as shown on the drawings. Each filling chute shall be flanged. A cleanout shall be provided at the end of the conveyor trough. Cleanouts shall be 4-inch diameter, suitable for connection to steel drain pipe. The portion of each trough that is not covered by the filling chute shall be covered by a minimum 12 gauge stainless steel hinged cover. The covers shall conform to CEMA Standard No. 300-24.
2. The conveyor shall be provided with inlet and outlet chutes as shown on the drawings. The chutes shall be fabricated from a minimum thickness as the troughs and acid passivated Type 316 stainless steel plate.

E. Conveyor Supports

1. The conveyor shall be furnished complete with supports suitable for mounting as indicated and required. The supports shall be shop fabricated from structural steel shapes and plates. All shop welding shall conform to the latest standards of the American Welding Society. All supports shall be acid passivated 316 stainless steel .
2. All piping and chutes or hoppers shall be supported to prevent the exertion of undue forces and moments on the conveyor flanges. Suitable flexible couplings shall be furnished to isolate the conveyor from the piping and chute systems. The conveyor will be mounted on a flat and level concrete slab suitable for supporting the dead weight of the equipment or suspended from the ceiling, as shown on the Drawings. The manufacturer shall provide all necessary floor or ceiling supports necessary for the conveyors. Manufacturer shall size and furnish anchor bolts for spiral conveyor equipment.

3. Supports shall be provided near the drive units (one to two feet) and at locations at a maximum of twelve feet apart along the conveyor.
4. Support loads shall be based on a completely filled trough plus dead weight of the equipment.

F. Drive Unit

1. Each screw conveyor shall be driven by an electric motor connected to a gear reducer. The gear reducer shall be mounted to the trough end. The drive system shall be designed for starting the conveyor fully loaded. All electric motors shall be provided in accordance with the requirements of Section 16222, Motors.

G. Gear Reducer

1. All gear reducers shall be commercially built, AGMA Class II, single, double, or triple reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the spiral flights and shall have the AFBMA B-10 life of 30,000 hours. The reducers shall be standard air-cooled units with no auxiliary cooling allowed. Low speed output shaft shall be chrome plated. Shaft seals shall be tripled lipseal with taconite packing designed for service conditions.

H. Holddown Provisions

1. Holddown provisions shall be installed on the shaftless screw conveyor if required by the manufacturer's design or if excessive vertical movement of the spiral flights occurs during the first year of operation. Evidence of excessive vertical movement shall include wear on the trough cover plates. Holddown provisions shall be of welded steel construction supported by the conveyor lid, and be designed to minimize material flow interruption. The holddown provisions shall be designed by the manufacturer.

I. Wear Liner

1. The replaceable liner of the troughs shall be UHMW polyethylene plastic impregnated with an anti-wear and molybdenum disulfate synthetic lubricant. The liner shall have a minimum thickness of 3/8-inch. The wear liner shall be SPIRAC Duraflo SPX or Xylethon by Durawear. The liner shall be a single piece, formed and bonded with two (2) layers, each of a different color, to provide a visible indication when the liner is nearing the end of its useful life. The liner shall be supplied in maximum 3.3 foot long sections to provide ease of replacement. The liner shall be held in place with stainless steel clips; no fasteners will be allowed. Liner thickness shall be at a minimum 3/8" thick and line the complete inside diameter of the transport section. Liners less than the specified minimum thickness, molecular weight, wear strips and steel or hardened steel shall not be acceptable.

The liner material shall have the following physical properties, as a minimum:

Property	Value/Unit	Testing Method
Density	61.2 lbs/ft ³	DIN53479
Molecular Weight	9.2x10 ⁶ g/mol	MARGOLIES
Ball Indentation Hardness	5,946 LBS/IN ²	DIN53456
Shore Hardness D	64	DIN53505

Crystalline melting range	278° F	
Dynamic coefficient of friction	0.1-0.12 RATIO OF TENSION/LOAD	PLASTIC TO STEEL

2. The liner is held in place with 316 stainless steel blocks at minimum one foot spacing along the edges parallel to the conveyor center line in addition to blocks being welded at the end of each liner and the beginning of the next liner.

J. Structural

1. The ratio of the unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for a compression member and shall not exceed 240 for any tension member (of angles about the Z-Z axis). In addition, all structural members and connections shall be design so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subject to loading of twice the running torque of the drive motor.

K. Flexible Boot

1. Provide a flanged flexible boot bolted to the conveyor discharge chute flanges. The flexible boot shall be black molded neoprene or Hypalon, 2-ply fabric reinforced with polyester cord, and complete with 316 stainless steel backup flanges and hardware. The boot flanges are to match the dimensions of the chute. Provide chutes in 4 ft. maximum flanged sections too allow varying the length of the chutes.

L. Safety Devices

1. Motion Detector: A motion switch with reset to detect under speed or zero speed shall be provided with each conveyor. The unit shall have a time delay to allow the selected machine to accelerate and have sufficient range on the calibration to be able to detect decrease in speed as an alternative to motion failure. The unit shall detect failure in the forward or reverse directions if required.
2. Emergency Stop Switch with Cable Operator: Provide conveyor with an emergency stop system consisting of pull-chord switches actuated by a cable system running the full length of the conveyor. Cable shall be orange-colored, plastic-covered steel aircraft cable. Provide all cable end fittings and all intermediate cable support eyes. Provide cable support eyes every ten feet. Provide switches as required to limit the required actuating force to OSHA guidelines. The switches shall be manually set after actuation and shall provide visual indication of operation. Switch shall be single-pole, double-throw output contact, rated for inductive load of 5 amps at 120V ac. Switch shall be normally closed and shall open when pull-chord switch is actuated. Actuator arm shall be 316 stainless steel. Emergency stop switches shall be as manufactured by Conveyor Control Components, Crouse-Hinds or approved equal.

2.4 CONTROLS

A. General

1. The paragraphs below address system electrical and controls requirements. Refer to related sections as indicated.

B. Operation

1. This facility is to be largely controlled from the plant control system. This screw conveyor system shall include interfaces with the plant control system as described herein and shown on the process and instrumentation diagrams. Refer to Section 13475 for plant control system functions.
2. The systems covered in this specification shall include all required interfaces specified herein, plus functions within the package system as needed to provide a complete, operable system.
3. Provide a control panel containing control components, operator interfaces, and other devices as required.
4. The conveyor shall be operable locally from the control panel, and control shall be passed to the plant control system when selected REMOTE at the control panel.

C. Control Panel Requirements

1. Control panels shall meet all applicable requirements described in Sections 13400 and 16000, including, but not limited to requirements for submittals, components, materials, and workmanship. Components include all those parts used in the package control system which are covered in 13400 and 16000.
2. Control panels shall be 316 stainless steel, NEMA 4X. Mounting shall be as shown on the drawings.
3. A panel space heater shall be provided within each control panel to prevent condensation.
4. Operator Interfaces. The control panels shall include the following minimum front of panel operator interfaces.

Local/Remote selection

Start/Stop pushbuttons

Control power ON indication

Conveyor ON (running) indication

EMERGENCY STOP mushroom head pushbutton

FAIL indication (on low motion, or overload, or emergency stop fail shall occur, and all conveyors shall be stopped and locked out until RESET. Provide individual indicators for each conveyor)

RESET pushbutton

Elapsed time indication for each conveyor

Other indications/alarms as necessary to properly operate and troubleshoot the system

5. Control Panel Outputs: Provide the following dry contact outputs, rated no less than 5 amps at 120 volts 60 Hz or 24 vdc:

FAIL (close on FAIL, a unique signal for each conveyor).

CONVEYOR ON (close on ON, a unique signal for each conveyor).

REMOTE selected (close on REMOTE, a unique signal for each conveyor)

6. Control Panel Inputs: The control panel shall accept the following dry contact inputs, which shall control when the conveyor is selected REMOTE, which will be suitable for use with either 120V, 60 Hz or 24 Vdc sensing voltage provided by the control panel.
7. Conveyor RUN command (momentary commands, control panel should latch and drive the gate to desired position. Unique commands for each gate).
8. OPEN/CLOSE commands (momentary commands, control panel should latch and drive the gate to desired position. Unique commands for each gate).
9. EMERGENCY STOP (a single input, open on STOP, to accept the command from locations other than those specified here).

D. Other Requirements.

1. On loss of power, then restoration, when selected for LOCAL operation the control panel shall not automatically restart the conveyor. Thus, momentary START/STOP control within the control panel is required, and this circuit shall accept the maintained RUN command for REMOTE operation.
2. The system shall include an electrical disconnect meeting the requirements of the National Electrical Code
3. Overall interconnection schematics are required by Section 16000. The supplier of the systems specified in this Section shall provide information and prepare documentation as required in the development and submission of the interconnection schematics.
4. The controls provided under this section shall protect the equipment provided. The supplier shall submit documentation stating that the equipment is protected by the controls furnished under this section. For any out of range conditions which could occur when under remote control and cause damage, they shall be described and submitted in accordance with Section 01340.

2.5 MOTOR:

- A. Electric motors shall be suitable for a Class 1, Div. 1 environment, heavy duty, and chemical duty suitable for corrosive environment. The design of all drive components shall be such that jamming of any components shall not cause damage to the equipment. Provisions shall be installed as required to protect the equipment.

2.6 SPARE PARTS

- A. The following spare parts shall be provided the shaftless screw conveyor:

1. One shaft seal
2. One standard length spiral flight with flanged connection 10 ft long
3. Four wear liner panels

2.7 PROTECTIVE COATING

- A. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents.

2.8 MANUFACTURERS

- A. MANUFACTURER's Experience: The contractor shall provide products which have at least 5 years in operation. No equipment shall be considered which has an operating history of less than 15 years. Manufacturer shall have a minimum of 25 units in operation in the U.S. for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The CONTRACTOR shall assign to a single Supplier full responsibility for the furnishing and functional operation of the complete shaftless screw conveyors. The designated single Supplier, however, need not manufacture more than one part of the unit, but shall coordinate the design, assembly, testing, and erection of the unit as specified herein..
- C. Manufacturers or Equal:
 1. Keystone Conveyor Corporation.
 2. Spirac, Inc.
- D. Any use of substitute equipment shall not relieve the CONTRACTOR of providing a complete and operable system in complete conformance to the specifications, including all performance parameters and interfacing requirements.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.

3.3 TESTING

- A. General

1. Provide testing in accordance with Section 01650 Facility Startup.

B. Factory Testing

1. The conveyor drive system shall be assembled and given no-load running tests at the manufacturer's plant before shipment.

C. Functional Testing

1. The equipment shall be field tested after installation, in accordance with the Contract Documents, to demonstrate satisfactory operation, without causing excessive noise, vibration, and overheating of the bearings. The field testing shall be performed in the presence of an experienced field representative of the manufacturer of each major item of equipment, who shall supervise the following tasks and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:
 - a. Start-up, check, and operate the equipment over the entire speed range.
 - b. Electrical testing shall conform to applicable sections of these Specifications.
 - c. The field testing shall be witnessed by the ENGINEER. In the event any of the equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of these specifications. The CONTRACTOR shall then certify in writing that the equipment has been satisfactorily tested, and that all final adjustments thereto have been made. Certification shall include date of final acceptance test, as well as a listing of all persons present during tests, and resulting test data. The costs of all work performed in this Paragraph by factory-trained representative shall be borne by the CONTRACTOR.

END OF SECTION

SECTION 14600 – HOISTS, CRANES AND WINCHES, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish, install, and place in satisfactory operation the hoisting equipment and appurtenances complete with all necessary safety equipment, in accordance with the requirements of the Contract Documents.
- B. The CONTRACTOR shall confirm that the crane dimensions and capacity meet the lifting requirements for the equipment provided.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AISC	Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings
AGMA	American Gear Manufacturers Association
ANSI B30.11	Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoists)
ANSI B30.16	Portal, Tower, and Pillar Cranes
ANSI MH 27.1	Specifications for Underhung Crane and Monorail Systems
ASTM A 36	Specification for Structural Steel
CMA	Crane Manufacturer's Association of America
NEMA	National Electrical Manufacturers Association.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 Submittals.
- B. Shop Drawings and Samples: The CONTRACTOR shall submit complete shop drawings of all hoist and crane equipment in accordance with the requirements of the Section 01300 – Submittals. Such shop drawings shall include all weights, loads, dimensions, and clearances required.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Quality Assurance: CONTRACTOR shall submit the following:

1. Manufacturer's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. Manufacturer's printed installation instructions
6. Suggested list of spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

1.4 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
1. 0.25 person-days for installation assistance and inspection,
 2. 0.25 person-days for functional and performance testing
 3. 0.25 person-days for training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

- A. The CONTRACTOR shall furnish and install all hoist, winches, and crane equipment specified below. Equipment of similar design shall be from the same manufacturer.
- B. The capacity of each hoist shall be permanently marked in a conspicuous manner on the equipment. The wire rope reeving shall be of the two-part double, cross mounted or similar appropriate type, to provide a true, vertical lift without drift, unless otherwise specified.
- C. All hooks shall be safety type with latch.
- D. The CONTRACTOR shall verify all dimensions and clearances in the field prior to erection and shall be responsible for the proper fitting and operation of the equipment.

2.2 BASIC MATERIALS

- A. All materials used must be new and of the best commercial grade. Where materials are not specified, the CONTRACTOR shall have the manufacturer use the most suitable selection for the given application and environment.

2.3 PLANT FABRICATED ITEMS

- A. All fabrication, assembly, and welding shall be carried out by factory-trained specialists and certified welders.

2.4 PORTABLE DAVIT CRANE

- A. General: Provide manual hand winch portable davit crane and wall mounted posts for removal of the secondary polishing disc filters. Cranes shall meet the requirements of that latest ANSI B30.16 standard. Each crane shall have a permanent pedestal installed as shown on the Contract Drawings.
- B. Capacity: 1100 lbs with 80 inch horizontal boom length
- C. Rope: 36 ft length, 316 SS, ¼" min diameter
- D. Materials of construction: Crain components and posts shall be 316 SS
- E. Weight: Crane and winch shall weigh no more than 100 lbs each.
- F. Manufacturers; or equal
 - 1. Thern
 - 2. Wallace

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All hoist and crane equipment shall be installed in strict accordance with the manufacturer's printed instructions and the CONTRACTOR shall arrange to have all installation performed under the guidance of the manufacturer's field representative.

3.2 WORKMANSHIP

- A. The workmanship shall be in accordance with the referenced standards and codes.

3.3 INSTALLATION; CONSTRUCTION; APPLICATION; ERECTION; ETC.

- A. Care shall be taken, that the structural integrity of beams, columns, walls, floors, and roofs will be maintained at all times.

3.4 EXECUTION OF TEST PROCEDURES; VALIDATION; ETC.

- A. After completion of the WORK, the CONTRACTOR shall test all hoist and crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets all applicable standards and specifications.

END OF SECTION

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SECTION 14700 – TURNTABLES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install a turntable used for rotating a truck as shown in the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. ASTM
- B. AWWA
- C. ASME
- D. ANSL
- E. NFPA
- F. ANSI/AWS
- G. AASHTO

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections. Shop drawings shall be reviewed and stamped by a licensed California Professional Engineer.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 Submittals.
- C. Electrical Drawings: Electrical drawings, electrical power requirements, wiring diagrams, conduit runs, controls, and control wiring shall be submitted.
- D. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- E. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- F. Welding: All welding shall be performed by welder qualified according to ANSI/AWS Structural Welding code D1.1. Copies of welder qualifications shall be provided upon request. Welding shall be inspected and approved by a welding inspector certified under Section 6.1 of AWS Specification CWI-96 and copy of his or her certification shall be available upon request.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall submit the following:

1. MANUFACTURER's Certificate of Proper Installation
2. Functional Test Certification
3. Factory performance test reports
4. Special shipping, storage and protection, and handling instructions
5. MANUFACTURER's printed installation instructions
6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty, unless stated otherwise herein.
2. All equipment shall be accompanied by a 5-year MANUFACTURER'S warranty.
3. Warranty shall be a total system warranty that shall cover defects in materials, function, labor, and workmanship.

C. Welding

1. All welding shall be performed by welder qualified according to ANSI/AWS Structural Welding code D1.1. Copies of welder qualifications

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

A. Manufacturer's Representative. In accordance with the requirements of Section 01730 - Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 2 person-days for installation assistance and inspection,
2. 2 person-days for functional and performance testing
3. 1 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL

A. The requirements of Section 11000 – Equipment General Provisions apply to this section.

2.2 PERFORMANCE REQUIREMENTS

A. The turntable shall have the following engineering criteria described below:

1. Equipment shall be capable 50,000-lb rotating load.
2. The deck shall be able to support 20,000-lb 4-wheel point-load or 40,000-lb per-axle load anywhere on its surface. Maximum stress in any structural steel element shall not exceed 18,000 psi.
3. Speed of rotation shall be fixed at no greater than one revolution per minute in clockwise and counterclockwise directions.
4. Maximum stress in any structural steel element shall not exceed 15,000 psi.
5. Maximum deflection of any structural element shall not exceed 1/500 of its unsupported span.

2.3 MATERIALS AND FABRICATION

A. Wheels

1. One row of heat treated alloy steel wheels shall be furnished and supported by roller bearings pillow blocks. Wheels shall be set near the turntable perimeter and spaced equally apart. Each wheel shall be precision tapered to impart smoother, circular motion to the turntable and disposed in such a manner that extension of the center of rotation shall intersect the dynamic center of revolution of the turntable.
2. Heat treatment shall take place only after machining the shape of the wheel to provide correct surface hardness relative to the track.
3. Any single wheel shall be rated to support a truck 20,000-lb 4-wheel load plus the dead weight of the turntable above it. There shall be no fewer than 16 wheels and each wheel shall have 8-inch diameter by 3-1/2-inch face minimum dimensions. Multiple concentric rows of wheels, polymer, wheels, crowned or cylindrical wheels shall not be permitted.

B. Track

1. A rolled steel crane-rail track of 60-lb minimum cross section and 4-1/4-inch height to permit reasonably uniform distribution of loads on the foundation shall be provided. The track must be factory manufactured and tested with its mounting plates and with conventional mechanical attachment devised so that no field welding is required during installation. Track fabricated from plate steel is unacceptable.

C. Center Post

1. A center post shall be of machined steel plates housing a heavy duty, large diameter ball bearing suitable to support maximum vertical loads and to adequately resist horizontal loads exerted by acceleration or deceleration of a vehicle traveling at normal speeds within a loading dock area.

2. The bearing shall have a 43-inch minimum diameter at the race.

D. Floor Structure

1. Floor structure shall be a series of radial circumferential and chordal structural beams supporting a diamond plate steel deck. The deck plate will be of adequate thickness and suitably supported to withstand a 20,000-lb, four-wheel vehicle point load.
2. Floor structure shall have a minimum of 32 radial beams with 10-inch by 15# WF minimum section.
3. Deck plate will be fastened to the supporting structure using mechanical fasteners and shall require no field welding. Deck plate shall include 2 service hatches for periodic inspection and service. Deck plate shall be acid passivated Type 316 stainless steel with diamond treads.

E. Curb Angle:

1. A heavy duty rolled steel angle with nelson studs shall be supplied for installation around the turntable pit edge after completion of the turntable installation and embedded in a second pour of concrete.
2. The curb shall be at least 2-inch by 2-inch by 1/4-inch minimum section. The gap between the turntable and the fixed floor shall be no more than 3/4 inches and vary no more than 1/4 inches.

F. Drive

1. The turntable shall be driven by means of one of the following systems:
 - a. A spring loaded, self-compensating, dual-wheel traction drive system
 - b. A pin-gear drive system that provides accurate and consistent torque
2. Drive system based on friction or pinch wheels or similar drive arrangements are not permitted.

2.4 CONTROLS

- A. Controls shall be supplied per Section 13400 Instrumentation and Control System and Section 13475 Control Strategies, unless stated otherwise herein.
- B. All electrical components shall be UL508 certified and complying with local requirements.
- C. The drive motor shall be operated by a controller/starter in a NEMA-12 enclosure with push-button controls for forward, reverse, and stop modes.

2.5 MOTOR

- A. Motor shall be in accordance with Section 16222 Motors, unless stated otherwise herein.

- B. The turntable shall be driven by means of a spring loaded, self-compensating, dual-wheel traction drive system powered by a 2-HP explosion proof AC motor.

2.6 FABRICATION

- A. Fabricate equipment with machinery and tools specifically designed for the intended manufacturing processes and by skilled tradesmen.
- B. Fabricate with materials, component sizes, metal gauges, reinforcing, anchors, and fasteners of adequate strength to withstand intended use, and within allowable design factors imposed by jurisdictional authorities and equipment loading as specified herein.
- C. Ensure that equipment will remain free of warping buckling, opening of joints and seams, distortion, and permanent deformation.
- D. Accurately cut, machine and fit joints, corners, copes, and mitres so that junctions between components fit together tightly and in true planes.
- E. Allow for differential movements within assemblies and at junction assemblies with surrounding Work.
- F. All moving parts shall be factory lubricated so that lubrication is not required for another 6 months, under normal use. Provisions shall be made in the design for lubricating all moving parts after installation.

2.7 EQUIPMENT LABELLING

- A. Equipment shall have a non-corrosive nameplate securely attached to it showing the manufacturer's name, address, website and telephone number, as well as the model and serial number for that equipment.
- B. A legible nameplate shall be fastened to the equipment in an easily accessible location.

2.8 SPARE PARTS

- A. The requirements of Section 11000 – Equipment General Provisions apply to this section.
- B. The following spare parts shall be provided with the turntable:

Item	Quantity
Support wheels	8
Drive pinion	1

2.9 PROTECTIVE COATING

- A. Materials and equipment shall be coated in accordance with Section 09960 Protective Coatings and the Contract Documents unless specified otherwise herein.
- B. All turntable components shall be hot dip galvanized for corrosion protection. All machined surfaced shall be properly protected against rust, corrosion, and mechanical damage.

- C. Coatings shall not interfere with or cover equipment and control labels.

2.10 MANUFACTURERS

- A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized turntables for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: The CONTRACTOR shall assign to a single Supplier full responsibility for the furnishing and functional operation of the complete turntable system. The designated single Supplier, however, need not manufacture more than one part of the unit, but shall coordinate the design, assembly, testing, and erection of the unit as specified herein.
- C. Manufacturers, or equal:
 - 1. The Macton Corporation
 - 2. Carousel USA

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. Install in accordance with the MANUFACTURER's printed instructions.
- B. Field engineer shall be present at all times during the field installation of the equipment. Such field engineer must be an employee of the manufacturer of the equipment and must have been present during the assembly and testing of the equipment, including major structural items in the equipment.
- C. Full or partial manufacture or fabrication on the project site shall not be permitted by either the general contractor or the turntable supplier.
- D. No field welding shall be permitted on the functional elements or structure of the turntable.

3.3 TESTING

- A. General
 - 1. Provide testing in accordance with Section 01660 Testing and Training.

B. Factory Testing

1. Track shall be factory tested with its conventional mechanical attachment devices.
2. MANUFACTURER to factory fabricate, assembly and test operation and functions of system and correct deficiencies, prior to delivery to Project site.
3. At the OWNER's request, at any time during the manufacture or testing of equipment, the equipment manufacturer shall allow access to their factory facility for OWNER'S and/or OWNER'S representative inspection of equipment and MANUFACTURER'S quality control processes

C. Functional Testing

1. The equipment shall be field tested after installation, in accordance with the Contract Documents, to demonstrate satisfactory operation, without causing excessive noise and vibration. The field testing shall be performed in the presence of an experienced field representative of the manufacturer of each major item of equipment, who shall supervise the following tasks and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:
 - a. Start-up, check, and operate the equipment.
 - b. Electrical testing shall conform to applicable sections of these Specifications.
 - c. The field testing shall be witnessed by the ENGINEER. In the event any of the equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of these specifications. The CONTRACTOR shall then certify in writing that the equipment has been certify in writing that the equipment has been satisfactorily tested, and that all final adjustments thereto have been made. Certification shall include date of final acceptance test, as well as a listing of all persons present during tests, and resulting test data. The costs of all work performed in this Paragraph by factory-trained representative shall be borne by the CONTRACTOR.
2. At the OWNER's discretion, the MANUFACTURER shall arrange for the demonstration of the turntable equipment with OWNER personnel. The demonstration shall be performed by a technical representative of the MANUFACTURER covering the proper operation and care of the system.

END OF SECTION

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SECTION 15000 – PIPING, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all piping systems indicated, complete and operable, in accordance with the Contract Documents. The provisions of this Section shall apply to all piping sections in Divisions 2 and 15.
- B. The Contract Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Contract Drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, and connectors for a complete and functional system. Flanges and joints in addition to those shown may be necessary to facilitate fabrication and installation.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section; provided, that for Building Codes, the latest edition of the code, as adopted as of the date of award by the Owner having jurisdiction, shall apply to the Work.
- B. This Section contains references to the following documents. In case of a conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail. The latest edition of the following references at the time of bid shall be used:

ANSI/AWS D1.1	Structural Welding Code
ANSI A13.1	Scheme for the Identification of Piping Systems
AWWA M11	Steel Pipe Design and Installation Manual
MSS SP	Pipe Hangers and Supports - Materials, Design and Manufacture

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: Submittals shall be furnished in accordance Section 01300 - Submittals. Shop Drawings shall contain the following information:
 - 1. Drawings: Layout drawings including all necessary dimensions, details, pipe joints, fittings, specials, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate all spool pieces, spacers, adapters, connectors, fittings, and supports to accommodate the equipment and valves in a complete and functional system.

- B. Samples: All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increase in cost to the Owner.
- C. Certifications:
 - 1. All necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.
 - 2. Fabricator Statement: A statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

- A. General: To assure uniformity and compatibility of piping components in grooved-end piping systems, fittings and couplings shall be furnished by the same manufacturer. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance and manufacturer's service.
- B. Inspection:
 - 1. All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
 - 2. The Contractor shall notify the Engineer of the production schedule in sufficient time so that factory inspection can be arranged. Factory inspection will be made after the manufacturer has performed satisfactory checks, adjustments, tests, and operations. The extent of factory inspection and testing shall be as specified herein below and in the respective piping sections of these Specifications.
 - 3. The manufacturer shall make available for the Engineers use such gauges as are necessary for inspection. The manufacturer shall provide the Engineer with such assistance as is necessary for the handling of pipe and fittings.
 - 4. Approval of pipe at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the Engineer. Unless otherwise specified, the Owner will pay for expenses incurred for the factory test witness visits. The cost of performing the tests in the factory shall be included in the Contractor's bid.
- C. Welding Requirements. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, reinforcing plates and ring flange welds, and plates for lug connections.

PART 2 PRODUCTS

2.1 GENERAL

- A. Extent of Work: All pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and as indicated.

The pipe material required for each fluid application shall be in accordance with the Pipe Schedule. Where a pipe material type is not specifically designated on the drawings, the Contractor may select among the options presented in the Pipe Schedule. When a pipe material is specifically designated on the drawings, only that material will be allowed unless approved in writing by the Engineer.

- B. Pipe Supports: All pipes shall be adequately supported, restrained, and anchored in accordance with the requirements of Section 15006 - Pipe Supports, and as indicated. Where pipe support details are indicated, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate regardless of whether or not supporting devices are specifically shown.
- C. Lining: Application, thickness, and curing of pipe lining shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. The manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.
- D. Protective Coating: Application, thickness, and curing of pipe coating shall be in accordance with the requirements of the applicable Sections of Division 2, unless otherwise indicated. Pipes above ground or in structures shall be field-coated in accordance with Section 09960 – Protective Coatings.
- E. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 02640 - Pipeline Testing and Disinfection, or as indicated on the Piping Schedule.
- F. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.
- G. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1 - Structural Welding Code. Welding procedures shall be required for longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections. All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.
- H. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld splatter, pipe cuttings and filings, gravel, cleaning rags, etc., within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

2.2 PIPE FLANGES

- A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In., Class D, or ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, 150-lb class. Where the design pressure is greater than 150 psi up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E or Class F, or ANSI/ASME B16.5 150-lb class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI/ASME B16.5, 300-lb class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe, unless otherwise indicated. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. The Contractor shall coordinate the flange compatibility for pipes, valves, and equipment. Where connecting to existing flanges, the Contractor shall field verify existing flange dimensions. Flanges for miscellaneous small pipes shall be in accordance with the standards indicated for these pipes.
- B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or as indicated for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.
- C. Flange Bolts: All bolts and nuts shall be provided per "Bolts and Anchors" described below.
- D. Flange Gaskets: Unless specified for specific materials, gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of aramid fiber base, with nitrile binder and non-stick coating, suitable for temperatures to 700 degrees F, a pH of one to eleven, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted, unless otherwise indicated.
- E. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.
- F. Flange Gasket Manufacturers, or Equal:
 - 1. John Crane; Style 2160.
 - 2. Garlock; Style 3000.

2.3 INSULATION FLANGES

- A. Insulating Flange Sets: Insulating flange sets shall be provided where indicated, and as required by Section 13115 - Cathodic Protection System. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A325 -

Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength. Insulating gaskets shall be full-face.

B. Insulating Flange Manufacturers, or Equal:

1. JM Red Devil; Type E.
2. Maloney Pipeline Products Co., Houston.
3. PSI Products, Inc., (Frost Engineering Service Co., Costa Mesa, California).

2.4 THREADED INSULATING CONNECTIONS

- A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.5 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

- A. General: Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of ANSI/AWWA C606 - Grooved and Shouldered Joints. Bolts and nuts shall conform to the requirements of Section 05500 – Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling Manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections with mechanical-type couplings shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. All mechanical-type couplings on buried piping shall be bonded. The Contractor shall have the coupling manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer.

B. Manufacturers of Couplings for Steel Pipe, or Equal:

1. Gustin-Bacon (Aeroquip Corp.) (banded or grooved).
2. Victaulic Style 41 or 44 (banded, flexible).
3. Victaulic Style 77 (grooved, flexible).
4. Victaulic Style 07 or HP-70 (grooved, rigid).

C. Manufacturers of Ductile Iron Pipe Couplings, or Equal:

1. Gustin-Bacon, (Aeroquip Corp.).
2. Victaulic Style 31 (flexible or rigid grooving).

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Manufacturers of Couplings for PVC Pipe, or Equal:

1. Gustin-Bacon, (Aeroquip Corp).
2. Victaulic Style 775.

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

2.6 SLEEVE-TYPE COUPLINGS

- A. Construction: Sleeve-type couplings and flange coupling adapters shall be provided, in accordance with ANSI/AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe, and shall be of powder coated steel with Type 316 stainless steel bolts, without pipe stop, and be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05500 – Metal Fabrications. Buried sleeve-type couplings and bolts shall be fusion bonded epoxy-coated at the factory.
- B. Pipe Preparation: The ends of the pipe where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.
- C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:
 1. Color: Jet Black.
 2. Surface: Non-blooming.
 3. Durometer Hardness: 74 ± 5 .
 4. Tensile Strength: 1,000 psi minimum.
 5. Elongation: 175 percent minimum.
 6. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.
- D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of

an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

- E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed, unless thrust restraint is provided by other means. Harnesses shall be in accordance with the appropriate reference standard, or as indicated.
- F. Sleeve Type Coupling Manufacturers, or Equal:
 - 1. Dresser, Style 38.
 - 2. Smith-Blair, Style 411.

2.7 FLANGE COUPLING ADAPTERS

- A. Flange adapters shall be fabricated from high strength steel. Flanges shall be supplied to AWWA C207, as well as all ANSI standards. Compression ends shall have wedge gasket for efficient sealing. Gasket material shall be suitable for raw wastewater. All miscellaneous metalwork items shall be Type 316 stainless steel.
- B. Pipe ends shall be properly prepared for accepting the flange adapter in accordance with manufacturer's recommendations. The outside diameter and pipe type shall be verified prior to ordering adapters. Flange adapters shall be lined and coated with fusion bonded epoxy as specified in Section 09960 – Protective Coatings.
- C. Where cement mortar coated pipe is to be provided with sleeve type couplings, cement mortar coatings shall be heldback for coupling. Pipe shall be epoxy coated at location of coupling and cement mortar coating intersection.
- D. Flange Adapters Shall Be Manufactured By, or Equal:
 - 1. Dresser; Style 128.
 - 2. Smith-Blair.

2.8 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise indicated. The connectors shall be a minimum of 9 inches long, face-to-face flanges, unless otherwise indicated. The final material selection shall be approved by the manufacturer. The Contractor shall submit manufacturer's shop drawings and calculations.

2.9 EXPANSION JOINTS

- A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion

joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. The Contractor shall submit detailed calculations and manufacturer's shop drawings of all proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature and pressure ratings.

- B. For aeration air pipe provide metal expansion joint with non-controlled, hydroformed, high-corrugation stainless steel bellows. Shall be suitable for a maximum operating pressure of 50 psi as required by the system, and a temperature rating of 300 degrees F. Joints shall have an expansion/compression of plus/minus 3" or as required by the system, and have ANSI class 150 flanges, or grooved.
- C. Sliding-type expansion joints shall have flanged ends and limit rods.

2.10 RUBBER FLEXIBLE CONNECTORS (FABRIC REINFORCED)

- A. Flexible connectors shall be provided on the suction and discharge side of each pump, except sump pumps, and where shown on the Drawings. Where shown, flexible connectors shall be reducing, and/or eccentric.
- B. Flexible connectors shall be fabric reinforced neoprene with 125-pound flanged ANSI end connections rated for 100 psi cold water service. The connectors shall have filled arches specifically for wastewater service. The connectors shall provide a minimum of 1/4-inch axial compression, 1/8-inch extension, 1/4-inch lateral deflection, and 2 degrees angular flexibility. All units shall be suitable for vibration and connection to pumping units. Units shall be manufactured by, or approved equal:
 - 1. Holz Rubber Company, Inc.
 - 2. Garlock.
 - 3. Red Valve Company, Inc. – Redflex.
- C. Each flexible connector shall be furnished and installed with harness bolt control units to prevent joint separation due to hydraulic pressure. Number and size of Type 316 stainless steel harness bolts shall be as necessary to withstand test pressures plus 50 psi surge. The internal materials of the flexible connectors shall be resistant to wastewater. Flexible connector to be used outdoors shall have a cover coating to provide extra product protection against ultra-violet radiation, ozone, weather, and the environment, and shall be suitable for outdoor use.

2.11 PIPE THREADS

- A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), made up with Teflon tape, unless otherwise indicated.

2.12 PIPE INSULATION

- A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as shown, in accordance with the requirements indicated. No unprotected hot piping shall be within reach of operating personnel or other persons.

2.13 CATHODIC PROTECTION

- A. Where so indicated, buried piping shall be cathodically protected in accordance with Section 16640 - Cathodic Protection.

2.14 AIR AND GAS TRAPS

- A. Air and gas pipes shall be sloping to low points, provided with drip legs, shut-off valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-lb iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.
- B. Manufacturers, or Equal:
 - 1. Armstrong International, Inc.
 - 2. Spirax Sarco, Inc.

2.15 BOLTS AND ANCHORS

- A. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, carbon steel bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A307, Grade B where working pressures are 175 psi or less. For higher pressures, bolt material shall conform to the requirements of ASTM A193, Grade B7.
- B. Corrosive Service: Bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
 - 1. Buried locations.
 - 2. Submerged locations.
 - 3. Locations subject to seasonal or occasional flooding.
 - 4. Inside hydraulic structures below the top of the structure.
 - 5. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.
 - 6. Chemical handling areas.
 - 7. Inside trenches, containment walls, and curbed areas.
 - 8. Locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.
- C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel in accordance with ASTM A193, Class 2, Grade 8M or ASTM F593, Condition SH. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts shall be coated as specified in Section 13115 – Cathodic Protection System.
 - 1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.
 - 2. Antiseize lubricant shall be "Pure White" by Anti-Seize Technology, Franklin Park, IL; or equal.
- D. Bolt Requirements:

1. The bolt and nut material shall be free-cutting steel.
2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
3. Bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.
4. The length of bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.
5. All-thread studs shall be used on valve flange connections, where space restrictions preclude the use of regular bolts.

PART 3 EXECUTION

3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

- A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

3.2 INSTALLATION

A. General:

1. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 2 and 15.
2. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The laying of all pipe shall be in finished trenches free from water or debris. The lining and protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.
3. Clean out fittings, valves, and pipe sections before installing.
4. Furnish and assemble pipe and fittings to provide accurate alignment for joints.
5. Make all joints watertight.
6. Use an anti-seize compound on all bolt threads. Manufacturer's instruction for application shall be followed. The anti-seize compound shall be designed to prevent rusting and seizure of bolt threads and to prevent galling of stainless steel.
7. Provide temporary plugs or bulkheads for closure of the open ends of piping whenever work is stopped.
8. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.
9. In laying pressure pipelines, the deflection in a standard joint shall not exceed the manufacturer's recommendation. Deflections of more than 5 degrees shall require special bends or fittings. Departure from and return to established alignment and

- grade shall not exceed 1/16-inch per linear foot of pipe, and at no point shall the maximum departure from established line and grade be greater than 1-inch.
10. Each section of pipe shall be lowered into the trench, utilizing a sling or other device, in a manner that shall prevent injury to the pipe, coating, lining, or joints. In placing pipe in the trench, the pipe shall be held by the lowering device at the balancing point of the section. It shall not be dragged on the bottom of the trench, but shall be supported while being fitted into the adjacent section. Supporting the pipe on blocks, or blocking of any nature, either temporary or otherwise, will not be allowed.
 11. It is the responsibility of the Contractor, when the pipeline and appurtenances are finally laid, to see that all joints are protected and that any damage to the coating or lining of the pipe and fittings has been adequately repaired or replaced in order to preserve their integrity for corrosion protection.
 12. Repairs of defects that are discovered as a result of inspection or tests shall be made with new materials. Caulking of screwed joints, cracks, or holes will not be accepted. Tests shall be repeated after defects have been eliminated.
 13. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.
 14. Following assembly and testing, but prior to final acceptance, all pipelines shall be flushed with high velocity water or flushed with a cleaning ball. All accumulated construction debris and other foreign matter shall be removed. Flushing velocities shall be a minimum of 2.5 feet per second. Accumulated debris shall be removed through drains 2 inches and larger or by dropping spools and valves.
 15. The Piping Schedule lists the pressures at which all lines shall be tested.

B. Exposed Pipe:

1. Where not detailed, exposed pipe shall be installed in straight runs parallel to the axes of the structures. Pipe runs shall be horizontal and vertical, except that gravity lines shall have a minimum slope of not less than 0.5 percent, unless otherwise specified.
2. No exposed piping shall be erected until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat, efficient arrangement.
3. The Contract Documents shall be taken as diagrammatic for piping that is not shown in detail. Sizes of piping and their locations are indicated, but it is not intended to show every offset and fitting nor every structural difficulty that will be encountered during the installation of the Work.
4. The alignment of pipes shall be varied from that indicated on the Contract Documents, without extra expense to the Owner where necessary to avoid structural or mechanical difficulties or to avoid the work of any other trades. The Contractor shall furnish such parts and pieces as may be necessary to provide a complete and operable system.
5. Pipe work shall be suspended and supported in such manner as to prevent sagging or overstressing of pipe and connections and, furthermore, shall be supported so that no item of the piping system will transfer any load or stress to any equipment.
6. Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Flanges, unions, flexible couplings, and other connections shall

come together at the proper orientation. The fit shall not be made by springing any piping, nor shall orientation alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, etc. shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.

7. Piping shall be made up with a sufficient number of unions or flanged joints to permit ready breaking of lines as necessary for inspection and maintenance, in addition to such joints as are definitely shown on the Drawings.

3.3 TESTING

- A. All piping shall be tested in accordance with the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 15005 – PIPING IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish, mark, and install identification devices for all exposed piping using painting, lettering, flow direction arrows, and related permanent identification devices, and all appurtenant works, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ANSI A13.1 Scheme for the Identification of Piping Systems.

1.3 CONTRACTOR SUBMITTALS

- A. Product Data: Submit manufacturer's catalog literature for each product required.
- B. Samples: The Contractor shall submit samples of all types of identification devices to be used in the work to the Engineer, for approval prior to fabrication.
- C. The Contractor shall submit to the Engineer, for approval, a list of suggested wording for all valve tags prior to fabrication.
- D. All submittals shall be in strict accordance with the requirements of Section 01300 - Submittals.

PART 2 PRODUCTS

2.1 IDENTIFICATION OF PIPING

- A. Identification of all exposed pipe shall be accomplished by color-coding with painting and by lettering as specified in Part 3, herein, and in Section 09960 – Protective Coatings.
- B. Each pipe identification shall consist of painting, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels.
- C. Letter sizes and colors for lettering, arrows, and background shall conform to ANSI A13.1.
- D. Preprinted identification devices shall be as manufactured by:
 - 1. W. H. Brady Co.
 - 2. Seton Nameplate Corp., or equal.

2.2 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, the Contractor shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves, and appurtenances to the level specified herein.

2.3 IDENTIFICATION OF SHORT PIPE LENGTHS

- A. Identifying devices for sections of pipe that are too short to be identified with painting, lettered labels, and arrows shall be identified with metal or plastic tags as specified herein.
- B. Metal tags shall be of stainless steel with embossed lettering. Plastic tags shall be of solid black plastic laminate with white embossed letters. All tags shall be designed to be firmly attached to the short pipes or to the structure immediately adjacent to such short pipes.
- C. Factory-fabricated, flexible, semi-rigid vinyl, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All labels and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. All such tags or labels shall be readily visible from all normal working locations.
- B. VALVE TAGS
 - 1. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws. The wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "FA-THROTTLING", "3W-PUMP SHUT-OFF," etc.
 - 2. Install tags using corrosion-resistant chain. Number tags consecutively by location.
- C. PIPE IDENTIFICATION
 - 1. All unburied pipe, pipe in structures, and pipe in chemical pipe trenches shall be color-coded painted. The color code painting shall include all valves, supports, equipment and appurtenances to the piping system. Each pipe shall be labeled at intervals of 20 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches. Sections of pipe that are too short to be identified with painting, lettered labels, and directional arrows shall be tagged and identified similar to valves.

2. Pipe identification shall consist of 3 elements, i.e., painting, a lettered label, and a directional label.

3.2 IDENTIFICATION SCHEDULE

- A. Application of identifying devices shall conform to the following color codes:

Fluid Abbreviation	Function and Identification	Identification Color
1W	POTABLE WATER	safety blue
2W	NON-POTABLE WATER	green
3W	TREATED PLANT EFFLUENT	purple
BW	BACKWASH WATER	brown
CA	COMPRESSED AIR	safety yellow
CLS	CHLORINE SOLUTION, HYPOCHLORITE	safety yellow
D	DRAIN	brown
DG	DIGESTER GAS	yellow
DS	DIGESTED SLUDGE	brown
EA	EXHAUST AIR	yellow
EQR	EQUALIZATION BASIN RETURN	gray
EQR	EQUALIZATION BASIN SUPPLY	gray
FA	FOUL AIR	light gray
FC	FERRIC CHLORIDE	safety green
FE	FINAL EFFLUENT	purple
FI	FILTER INFLUENT	purple
FOR	DIESEL FUEL OIL RETURN	orange
FOS	DIESEL FUEL OIL SUPPLY	orange
FT	FILTRATE	brown
G	GRIT	brown
HWR	HOT WATER RETURN	light blue
HWS	HOT WATER SUPPLY	light blue
IA	INSTRUMENT AIR	white
NG	NATURAL GAS	yellow
OF	OVERFLOW	same as corresponding fluid
P	POLYMER (LIQUID)	orange
PD	PUMPED DRAIN	brown
PE	PRIMARY EFFLUENT	gray
PI	PRIMARY INFLUENT	gray
PS	PRIMARY SLUDGE	brown
PS/SCUM	PRIMARY SLUDGE/SCUM	brown
R	PLANT DRAINAGE RETURN	brown
RW	RECYCLED WATER	purple
S	SEWER	brown
SC	SCREENINGS	brown
SCUM	SCUM	brown
SD	STORM DRAIN	gray

Fluid Abbreviation	Function and Identification	Identification Color
SE	SECONDARY EFFLUENT	light blue
SG	SLUDGE GAS	yellow
SLUDGE	SLUDGE	brown
SS	SANITARY SEWER	gray
SW	SEAL WATER	purple
TS	THICKENED SLUDGE	brown
TWAS	THICKENED WASTE ACTIVATED SLUDGE	brown
V	VENT	same as corresponding fluid
WS	WASTE SLUDGE	brown

END OF SECTION

SECTION 15006 – PIPE SUPPORTS

PART 1 PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide pipe supports, hangers, guides, and anchors, complete, in accordance with the Contract Documents. The pipe supports indicated on the Drawings generally reference standard details, which are representative of industry standards. Not all the supports required for a complete installation are shown, or specifically called out. The Contractor shall provide all the necessary supports required for all the loads imposed on the piping system, including gravity, seismic, thermal, and pressure. The support systems shall include lateral bracing for seismic loads, and anchor bracing for thermal expansion/contraction.
- B. Generally locations of pipe supports, hangers, guides, and anchors are shown. The Contractor is ultimately responsible for meeting requirements of this Specification including locating and providing of all the necessary supports for seismic and wind loads.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AISC
- B. ASTM A123
- C. ANSI/ASME B31.1

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be in accordance with Section 01300 – Submittals.
- B. Shop Drawings: Shop drawings shall include the following information:
 - 1. Drawings of location plan, pipe supports, hangers, anchors, and guides.
 - 2. Calculations for special supports and anchors.
 - 3. Catalog Cut Sheets: Submit manufacturers catalog data including load capacity.

1.4 QUALITY ASSURANCE

- A. Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

PART 2 PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Code Compliance: All piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1 - Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.
1. All pipe supports and restraints shall be designed to support their respective pipes under the maximum combination of peak loading conditions, including pipe weight, liquid weight, liquid movement, pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces, including but not limited to seismic forces, wind forces and forces applied during construction.
 2. The Contractor shall note that the pipe support details in the Drawings need to work as a system to resist seismic and wind forces. The Contractor shall install lateral supports as needed to resist the seismic and wind forces given on the Structural Drawings. For special supports not defined in the Contract documents, the Contractor shall submit design calculations, shall be submitted to the Engineer in accordance with Section 01300 – Submittals.
- B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.
- C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. All hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. All hanger rods shall be subject to tensile loading only.
- D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.
- E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. All spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the

compression of the spring. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

- F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. All components shall be structurally suitable to withstand all loads imposed.
- G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.
- H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.
- I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.
- J. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.
- K. Noise Reduction: To reduce transmission of noise in piping systems, all copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.
- L. Stock Parts: Where not specifically indicated, stock or production parts shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

2.2 MATERIALS OF CONSTRUCTION:

- A. General: All pipe support assemblies, including framing, hardware, and anchors, shall be Type 316 stainless steel construction, unless otherwise indicated. Reference to standard details with carbon steel elements shall be constructed of stainless steel.
- B. Submerged Supports: All submerged piping, as well as piping, conduits, and equipment in hydraulic structures below the top of the wall or within 36 inches of the water level, shall be supported with assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated. Reference to standard details with carbon steel elements shall be constructed of stainless steel for these conditions.
- C. Corrosive: All piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

2.3 SUPPORT SPACING

- A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Steel Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1-1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe:

a. Maximum Spans for Pipe Supported in Minimum:

1) 120 degree Contact Saddles (feet).

Nominal Pipe Diameter (inches)	Wall Thickness (inches)									
	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	43	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	35	40	44	47	50	52	56			

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

where:

t = Thickness (inches)
D = Diameter (inches)

L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
All Diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1-1/2	6
2 to 4	10
6 and Greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1-1/4	5.5
1-1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

7. Support Spacing for Schedule 80 Polypropylene Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	3
3/4	3.5
1	3.75
1-1/4	4
1-1/2	4.25
2	4.5
3	5.5
4	6
6	7.25
8	8
10	8.75
12	9.5

8. Support Spacing for Fiberglass Reinforced Plastic (FRP) Pipe:

Nominal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
2	8.8
3	10
4	11
6	12.7
8	13.4
10	14
12	15.4
14	16.2
16	17.3
18 and Greater	18

2.4 PROTECTIVE COATING

- A. Galvanizing: Unless otherwise indicated, all fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. Other Coatings: Other than stainless steel, non-ferrous, or galvanized supports, all supports shall receive protective coatings in accordance with the requirements of Section 09960 – Protective Coatings.

2.5 MANUFACTURERS, OR EQUAL

- 1. Basic Engineers Inc., Pittsburgh, PA.

2. Bergen-Paterson Pipesupport Corp., Woburn, MA.
3. Grinnell Corp. (Supply Sales Company), Cranston, RI.
4. NPS Products, Inc., Westborough, MA.
5. Power Piping Company, Pittsburgh, PA.

PART 3 PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the parts and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.

3.2 INSTALLATION

- A. General: All pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ANSI/ASME B31.1 - Power Piping. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.
- B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. All hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.
- C. Provide clearance in hangers and from structure and other equipment for installation of insulation.

END OF SECTION

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SECTION 15025 - STEEL PIPE (ASTM A53/A106, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all steel pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/ASME B16.3	Malleable Iron Threaded Fittings, Classes 150 and 300
ANSI/ASME B16.4	Cast Iron Threaded Fittings, Class 125 and 250
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI/NFPA 70	National Electric Code
ASTM A53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105	Specification for Forgings, Carbon Steel, for Piping Components
ASTM A106	Manual M11, C200, C208

1.3 CONTRACTOR SUBMITTALS

- A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01300 – Submittals.
- B. Shop Drawings: The contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated
- C. Manufacturer's written Quality Assurance/Control Program.
- D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. The manufacturer shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All pipe sections and fittings shall be marked at each end with top field centerline.

2.2 PIPE MATERIAL

- A. Pipe for water and wastewater process fluids 3 inches and diameter and above shall be mortar lined black steel pipe with flanged or grooved couplings joints. All pipe shall conform to ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or AWWA C200. All pipe 12 inches in diameter and less shall be Schedule 40, all pipe greater than 12 inches in diameter shall have a minimum wall thickness of 1/4 inch, unless otherwise required by Division 2 for the design pressures.
- B. For Air, Fuel Gas, and Oil Service: Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A106 - Specification for Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.
- C. Chlorine and Sulfur Dioxide Pressure Service: Black steel pipe shall conform to Chlorine Institute Pamphlet 6, ASTM A106, Grade A or B, and shall be Schedule 80. Except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, and protective diaphragms for gages and switches, all fittings shall be

socket welded. Socket welded fittings shall conform to ASTM A105, Grade 2 and ANSI B16.11, 300 lb, forged carbon steel. Bushings will not be allowed.

2.3 PIPE JOINTS

- A. Black steel pipe for general service below 3 inches in diameter shall have screwed ends with NPT threads, welded joints, or flanged joints. Screwed joints shall be made up with Teflon tape and welded joints may have butt-weld fittings, or socket-weld fittings.
- B. For all pipe 3 inches and above, black steel pipe shall have flanged ends, grooved ends for shouldered couplings or plain ends for sleeve-type couplings. Field welding of joints shall not be allowed unless there is an acceptable method of mortar lining repair.
- C. Black steel pipe for chlorine or sulfur dioxide pressure service shall be socket-welded except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, diaphragm units, gauges, and switches.
- D. Galvanized steel pipe shall have screwed ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.
- E. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

2.4 FITTINGS

- A. Common Use: The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:
 - 1. Threaded malleable iron fittings conforming to ANSI/ASME B16.3 – Malleable-Iron Threaded Fittings, Classes 150 and 300.
 - 2. Threaded cast iron fittings conforming to ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
 - 3. Forged steel socket welded fittings conforming to ANSI/ASME B16.11 - Forged Fittings, Socket - Welding and Threaded.
 - 4. Butt welding fittings conforming to ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.
 - 5. Threaded cast iron drainage fittings conforming to ANSI/ASME 16.12 - Cast Iron Threaded Drainage Fittings.
 - 6. Flanged cast iron fittings conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
 - 7. Flanged steel fittings conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
 - 8. Grooved ductile iron fittings with grooving dimensions conforming to ANSI/AWWA C606 - Joints, Grooved and Shouldered Type.

9. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

- B. Special Applications: Fittings for chlorine and sulfur dioxide under pressure shall be 3,000 lb forged steel socket welded fittings conforming to ASTM A105, Grade 2 - Specification for Forgings, Carbon Steel, for Piping Components, and 300 lb forged steel fittings conforming to ANSI/ASME B16.11, as indicated in the Piping Schedule.
- C. Flanges for chlorine and sulfur dioxide pressure service shall conform to ASTM A105, ANSI/ASME B16.5, Class 300, with 1/16-inch raised face, with 1/16-inch high temperature, compressed, self-centering ring type gaskets conforming to ANSI/ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges. Unions shall be four bolt tongue and groove, ammonia type, suitable for chlorine and sulfur dioxide service, with female threads and lead gaskets.
- D. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions. Unions shall be rated for 500 lb CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment.

2.5 PIPE LINING

- A. Mortar lining shall be provided on all black steel pipe for all water and wastewater process fluids. The mortar lining shall be in accordance with Division 2.

2.6 PROTECTIVE COATINGS

- A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09960 – Protective Coatings.

2.7 MANUFACTURERS OR EQUAL

- A. Ameron
- B. Northwest
- C. U.S. Pipe

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.
- B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall

be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

- A. General: All steel pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site, to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.
- B. Pipe Preparation: Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assemblage.
- C. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.
- D. Installation Tolerances: Each section of pipe shall be installed in the order and position shown on the laying diagram and in accordance with the following:
 - 1. Each section of pipe having a nominal diameter less than 48 inches shall be installed to line and grade, within plus or minus 2 inches horizontal deviation and plus or minus 1-inch vertical deviation.
 - 2. Each section of pipe having nominal diameter 48 inches and larger shall be installed to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.
 - 3. In addition to the horizontal and vertical tolerances above, install the pipe so that no high or low points other than those on the laying diagram are introduced.
- E. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.
- F. Valves and Unions: Water, steam, condensate, gas, vacuum, and air supply piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.
- G. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment.

- H. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.
- I. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.
- J. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the Manufacturer's recommendations and conform to ANSI/AWWA C606. All grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.
- K. Push-On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

3.3 TESTING

- A. All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired to the satisfaction of the Engineer.
- B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Process Fluid Pipe Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements, refer to Section 02640 – Pipeline Testing and Disinfection.
 - 1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
 - 2. After completion of the pressure tests, all chlorine gas piping shall be tested for leakage using chlorine gas under operating pressures. Piping shall be thoroughly clean and dry before admitting chlorine gas into the system. Chlorine shall be slowly admitted to the piping system. Leakage shall be checked with a swab soaked in aqua ammonia solution and waved in the vicinity of each fitting. Ammonia solution shall not be applied to the fittings. Formation of white fumes will be evidence of leaks. All chlorine gas shall be purged from the line before leaks are repaired.
 - 3. Leaks shall be repaired to the satisfaction of the Engineer, and the system shall be retested until no leaks are found.

END OF SECTION

SECTION 15030 – STAINLESS STEEL PIPE (ASTM A312, MODIFIED)

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all stainless steel pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

- B. Commercial Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11.80	Forged Steel Fitting, Socket Welded and Threaded
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe
ASME Section IX (1989)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A320/A320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fitting

ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

1.3 CONTRACTOR SUBMITTALS

- A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01300 - Submittals.
- B. Shop Drawings: The contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated
- C. Manufacturer's written Quality Assurance/Control Program.
- D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional

samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 PIPE MATERIAL

- A. Unless otherwise indicated, stainless steel pipe shall be in accordance with ASTM A312 - Specification for Seamless and Welded Austenitic Stainless Steel Pipe, Type 316, seamless, Schedule 40, with screwed fittings for sizes up to and including 2-1/2 inches, and welding fittings or flanged fittings for sizes 3 inches and larger. Stainless steel pipe 12 inches in diameter and larger shall be in accordance with ASTM A409 - Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service, or A778 - Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products, Type 316, of the schedules indicated, with welded or flanged joints.

2.2 STAINLESS STEEL TUBING

- A. The Contractor shall furnish and install stainless steel tubing for instrument air 3/8-inch and smaller. Stainless steel tubing shall be of the size indicated on the drawings or, if not indicated, shall be sized to adequately perform the function intended. In no case shall tubing be less than 1/4-inch outside diameter.
- B. Stainless steel tubing shall be used for all control or instrument air piping. Stainless steel tubing shall be seamless tubing made of Type 316 stainless steel and shall conform to ASTM A269. Wall thickness shall be adequate for test pressure specified, but shall not be less than 0.035 inch.
- C. Fittings for use with stainless steel tubing shall be of the swage type (flare, bite, or compression types are not acceptable), and all components shall be made of Type 316 stainless steel. Fittings shall be of the two ferrule design, resulting in a primary seal and two secondary seals. Fittings shall be Crawford Fitting Company "Swagelok", "Hoke Gyrolok", or equal. Valves for use with stainless steel tubing shall be air cocks of Type 316 stainless steel.

2.3 PIPE JOINTS

- A. Stainless steel pipe for sizes 2-1/2 inches and smaller shall have screwed ends with NPT threads made up with Teflon tape. Stainless steel pipe 3 inches and larger and where indicated shall have welded joints with socket-welding fittings, butt-welding fittings, or socket welding flanges. All stainless steel flanges shall have stainless steel bolts and nuts. Where indicated, stainless steel pipe shall have grooved ends for shouldered couplings, except that no pipe with less than Schedule 40 wall thickness shall be grooved. Where indicated, stainless steel pipe shall have plain ends for sleeve-type couplings.

2.4 FITTINGS

- A. Threaded Fittings: Forged stainless steel fittings conforming to ANSI/ASME B16.11 - Forged Fittings, Socket-Welding and Threaded, Type 316.

- B. Socket-Welding Fittings: Forged stainless steel fittings conforming to ANSI/ASME B16.11, Type 316.
- C. Butt-Welding Fittings: Wrought stainless steel butt-welding fittings conforming to ASTM A403 - Specification for Wrought Austenitic Stainless Steel Piping Fittings, and ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt-Welding Fittings, Type 316.
- D. Grooved Fittings: Wrought stainless steel grooved fittings conforming to ASTM A403 and ANSI/ASME B16.9, with grooving conforming to ANSI/AWWA C606 - Grooved and Shouldered Joints, Type 316.
- E. Flanged Fittings: Type 316 stainless steel flanged fittings and flanges conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- F. Pressure Class: Unless otherwise indicated, all fittings shall be in accordance with the pressure classes called for in the Piping Schedule. Where not indicated, the fittings shall have the same pressure rating as the pipe.

2.5 COUPLINGS

- A. Couplings and flange coupling adapters shall be of 304 stainless steel or fusion bonded epoxy coated steel. Gaskets shall be EPDM. Couplings and flange coupling adapter shall meet the requirements of Section 15000 Piping General.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.
- B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

- A. General: All stainless steel pipes shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.
- B. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 – Pipe Supports. Where

necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

- C. Valves and Unions: Unless otherwise indicated, all connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

3.3 PIPE PREPARATION

- A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assembly.

3.4 PIPE JOINTS

- A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.
- B. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.
 - 1. Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that other indicated welding requirements are followed rigidly.
 - 2. All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Euclean" or equal, followed by complete removal of the agent.
- C. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the Manufacturer's recommendations and conforming to ANSI/AWWA C606. All grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

3.5 INSPECTION AND FIELD TESTING

- A. Inspection: All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.
- B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The

Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements refer to Section 02640 – Pipeline Testing and Disinfection.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
2. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION

SECTION 15036 – COPPER PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all copper pipe and all appurtenant work, complete and in place, including connection to existing and new structures in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.
- B. Commercial Standards: In case of conflict between the requirements of this Section and those of the listed requirements the more stringent requirement shall be conformed to. The latest edition of the following references at the time of bid shall be used.

ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
Uniform Building Code	

1.3 CONTRACTOR SUBMITTALS

- A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01300 -Submittals and the follow supplemental requirements:
 - 1. List of pipe and fittings to be used
 - 2. Manufacturer
 - 3. Model Number
 - 4. Size and Schedule
 - 5. Material

- 6. Pressure Rating
- 7. Catalogue data
- 8. Drawings

- B. Shop Drawings: The Contractor shall submit detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information. Layout drawings shall also be submitted showing location of each pipe section and each special length. Each pipe shall be numbered in installation sequence and the pipe pressure class shall be indicated.
- C. Manufacturer's written Quality Assurance/Control Program.
- D. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. The manufacturer shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All pipe sections and fittings shall be marked at each end with top field centerline.

2.2 PIPE MATERIAL

- A. Copper pipe shall be hard drawn and shall conform to the requirements of ASTM B42 - Specification for Seamless Copper Pipe, Standard Sizes, with regular or extra strong wall thickness, as indicated in the Piping Schedule.

- B. Copper water tube shall conform to the requirements of ASTM B88 - Seamless Copper Water Tube, and shall be soft temper tube in rolls for buried locations, or hard drawn lengths for all other applications. Unless otherwise indicated, all copper water tube shall be of Type K wall thickness.

2.3 PIPE JOINTS

- A. Copper water tube shall have either: soldered joints, flared ends and fittings, or compression type joints. Soldered joints shall be made with 95 – 5 percent tin-antimony solder or with silver solder. Buried piping shall have flared or compression type joints. No soft-soldered joints will be allowed on buried piping. No solders containing more than 0.2 percent of lead shall be used. Copper pipe shall have screwed ends for NPT fittings or brazed joints. Screwed joints shall be made up with Teflon tape. Brazed or screwed joints may be used in connection with flanges and flanged fittings.

2.4 FITTINGS

- A. Threaded Fittings: Threaded cast bronze fittings for copper pipe shall be in accordance with ANSI/ASME B16.15 - Cast Bronze Threaded Fittings, Classes 125 and 250, as indicated in the Piping Schedule.
- B. Flanged Fittings: Cast copper alloy flanges and flanged fittings shall be in accordance with ANSI/ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings, and ASTM B62 - Composition Bronze or Ounce Metal Castings, with 150 lb rating, or as indicated.
- C. Flared Fittings: Flared fittings shall conform to ANSI/ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
- D. Compression Fittings: Compression type fittings shall be brass fittings as manufactured by:
 - 1. Crawford Company; SWAGELOK.
 - 2. Parker-Hannifin; CPI.
 - 3. Or equal.

2.5 PROTECTIVE COATING

- A. The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of primer compatible with the finish coating required by Section 09960 – Protective Coatings.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. Delivery and storage of steel pipe and appurtenances shall be in accordance with Section 15000 – Piping, General.
- B. The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment which might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on sand or earth

berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling. All pipe handling equipment and methods shall be acceptable to the Engineer. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

3.2 INSTALLATION

- A. General: All copper pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer.
- B. Pipe Preparation: Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. All pipe fittings shall be equally cleaned before assemblage.
- C. The Contractor shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The Contractor shall remove or smooth out any burrs, gouges, weld splatter, or other small defects prior to laying the pipe.
- D. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 15006 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Supports shall be copper-plated steel to prevent galvanic corrosion.
- E. Valves and Unions: Unless otherwise indicated, piping to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Low points in water systems and driplegs in steam, gas, and air systems shall have drainage valves. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.
- F. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe to avoid drainage of condensate into the equipment.
- G. Copper tubing for hot water shall be provided with silver brazing with insulation.

3.3 SOLDERING

- A. Solder Joints: All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, the flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and the flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints. Joints shall not be quenched after soldering.
- B. Solder used in copper piping shall be in accordance with ASTM B32, Grade 95 TA. Do not use cored solder.

3.4 PIPE JOINTS

- A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies and friction tools. Not more than three threads shall remain exposed after installation.
- B. Brazed Joints: Brazed joints shall conform to the specifications and recommendations of ANSI/ASME B31.1 - Power Piping. All welding shall be done by skilled and qualified welders per Section 15000 – Piping, General.

3.5 INSPECTION AND FIELD TESTING

- A. Inspection: All finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.
- B. Field Testing: Prior to enclosure or burying, all piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner. For additional testing requirements, refer to Section 02640 – Pipeline Testing and Disinfection.
 - 1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines be plugged or capped as required during the testing procedures.
 - 2. Leaks shall be repaired to the satisfaction of the Engineer, and the system shall be retested until no leaks are found.

END OF SECTION

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SECTION 15060 – POLYVINYL CHLORIDE SOLVENT WELDED PIPE

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install all exposed and buried solvent welded PVC piping and all appurtenant work, complete in place, including connection to existing and new structures, all in accordance with the requirements of the Contract Documents.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.
- C. PVC gasketed pipe is specified in Division 2 - Sitework.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

- B. Commercial Standards:

ASTM D1784	Rigid PVC Compounds and Chlorinated PVC Compounds.
ASTM D1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ASTM F441	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
ASTM D2774	Underground Installation of Thermoplastic Pressure Piping.
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
ASTM D3139	Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings.
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
ASTM F679	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F913	Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 CONTRACTOR SUBMITTALS

- A. For the materials and equipment items supplied under the provisions of this Section, the Contractor shall submit copies of the manufacturer's product specifications and performance details according to the requirements of Section 01300 Submittals, and the following supplemental requirements:
 - 1. List of Pipe Fittings to be used
 - 2. Manufacturer
 - 3. Model Number, if applicable
 - 4. Size and Schedule
 - 5. Material
 - 6. Pressure Rating
 - 7. Catalog Data
 - 8. Drawings
- B. Manufacturer's written Quality Assurance/Control Program.
- C. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.
- D. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as

supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

- B. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The Contractor shall perform all material tests at no additional costs to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor provided that the Contractor's schedule is not delayed for the convenience of the Engineer. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, conforming to ASTM D1785, unless otherwise shown. Elbows and tees shall be of the same material as the pipe. Unless otherwise shown, joint design shall be for solvent-welded construction to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.
- B. Joints: shall be joined using solvent cement in accordance with ASTM D2564 and ASTM D1784. Primers for use on solvent cement joints shall be in accordance with ASTM F656, and handling of primers and solvent cements shall conform to ASTM F402. Solvent cements shall comply with requirements for potable water use. Threaded and flanged joints shall be used where required.

2.2 CPVC (CHLORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. CPVC pipe, for hot, corrosive solutions and where shown, shall be made from all new rigid unplasticized chlorinated polyvinyl chloride, Class 23447-B, and shall be Schedule 80 conforming to ASTM F441, with solvent-welded fittings of the same material as the pipe, unless otherwise shown. Joints shall be made to the pipe manufacturer's specifications. Threaded joints shall be made with Teflon tape, only.

2.3 THREADED LUBRICANT

- A. Threaded lubricant shall be Teflon tape. Lubricant, if required, shall be suitable for lubricating the parts of the joints in the assembly. The lubricant shall have no deteriorating effects on the gasket and pipe material.

2.4 SOLVENT CEMENT

- A. All connections to be joined by PVC (polyvinyl chloride) solvent cement shall be industrial grade and shall conform to ASTM D2564 and shall bear a dated stamp on the container indicating the date of manufacture. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Primers used in solvent cement connections shall be in accordance with ASTM F656 and handling of primers and solvent cements shall conform to ASTM F402.

2.5 FLANGES

- A. PVC flanges shall be supplied with all necessary gaskets, bolts, and nuts. Gaskets shall be full face, 1/16-inch thick Viton.

2.6 GASKETS AND BOLTS

- A. Except as otherwise provided, gaskets for flanged joints shall be in accordance with the requirements of Section 15000 – Piping, General.
- B. Except as otherwise provided, bolts shall conform to the requirements of Section 05500 – Metal Fabrications.

2.7 PIPE INSULATION

- A. Chemical piping shall be insulated as shown, in accordance with the requirements indicated.

2.8 PIPE SUPPORTS

- A. Pipe Supports, hangers, anchors, and guides shall be in accordance with the requirements of Section 15006 – Pipe Supports.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. All pipe shall be handled or packaged in such a manner as to provide adequate protection for the pipe and the pipe ends during transportation from manufacturer, and supplier, to the site.
- B. Pipe and fittings shall not be stored in direct sunlight. Pipe shall be stored in such a manner as to prevent sagging or bending. Pipe supports shall be properly and adequately supported and anchored so as to maintain the supported loads in proper position under all operating conditions without unnecessary movement or strain on any piece of equipment. Thrust blocks shall be provided where necessary to resist system pressure on fittings.
- C. PVC solvent cements shall be stored in a cool place, except when actually in use during the joining process.

- D. Any section of pipe that has been dented or damaged or in any other way found to be defective, either before or after placing, shall be replaced with sound pipe without additional expense to the Owner.

3.2 INSTALLATION

- A. All rigid polyvinyl chloride (PVC) pipe shall be cut square, burrs removed, made up, and installed in accordance with the pipe manufacturer's recommendations, as approved. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and final use.
- B. Pipe shall not be laid when the temperature is below 40 degrees F, nor above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.
- C. Provide adequate ventilation when working with pipe joint solvent cement.
- D. PVC, CPVC pipe joints shall be solvent-welded in accordance with the manufacturer's instructions. Expansion joints or pipe bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise shown. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. The Contractor shall obtain the services of the pipe manufacturer, to instruct the pipe fitters in the correct way of making solvent welded and threaded joints. Only clean, fresh primer and solvent shall be used at all times at the recommended temperatures.
- E. The installation of plastic pipe valves; fittings and tubing shall be in strict accordance with the manufacturer's technical data and printed instructions, including the use of expansion joints and/or expansion loops, necessary for the piping to tolerate a 100 degree F change in operating temperature or any straight run of greater than 40 feet.
- F. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer.
- G. Particular care should be taken to avoid overstressing or breaking of the pipe at the sleeves.
- H. Underground installation of PVC pipe, fittings and valves shall be as specified below and in ASTM D2774.
- I. Where plastic pipe passes through walls, wall penetrations shall be made as shown on the Drawings.
- J. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings, nor shall plastic piping be threaded into metal valves, fittings or couplings.
- K. Where small piping is specified to be PVC (polyvinyl chloride) and is not specifically described herein, it shall be Schedule 80 with solvent weld joints as specified under above for water piping.

3.3 TESTING

- A. All lines shall be hydrostatically tested. Test procedures shall be as specified in Section 15000 – Piping, General and Section 02640 – Pipeline Testing and Disinfection.
- B. Prior to inspection and testing, stabilize piping by bringing it approximately to operating temperature before testing.
- C. Cure Period: A 24-hour cure period shall be required before the piping system is pressure tested.
- D. All leaks shall be repaired and all leaking lines retested as approved by the Engineer.

3.4 SUPPORTS AND HANGERS

- A. Pipe supports shall be as specified by manufacturer's recommendations and in accordance with Section 15006 – Pipe Supports.

3.5 DISINFECTION AND CLEANING

- A. All lines shall be cleaned, and all potable water lines shall be cleaned and disinfected, before being put in service, in accordance with Section 02640 – Pipeline Testing and Disinfection.

3.6 PAINTING

- A. All unburied polyvinyl chloride (PVC) piping shall be painted in accordance with Section 09960 – Protective Coatings.

END OF SECTION

SECTION 15061 – DOUBLE CONTAINMENT CHEMICAL TUBING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install reinforced PVC (RPVC) tubing in PVC conduit for ferric chloride chemical feed and all appurtenant work, complete in place, including connections to existing structures, all in accordance with the requirements of the CONTRACT DOCUMENTS.
- B. All pipe specified under this Section shall conform to the requirements of Section 15000 – Piping, General.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All work shall be performed in strict conformance with the industry standards, local laws, and ordinance specified in the General Requirements. Wherever the requirements of the specifications exceed those of these codes, the requirements of the specifications shall govern. Code compliance is mandatory. Nothing in these Contract Documents shall be construed as permitting work not in accordance with these laws and codes.

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be in accordance with Section 01300 - Submittals.
- B. Shop Drawings: CONTRACTOR shall submit shop drawings and samples in accordance with Section 01300 Submittals.
- C. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards.
- D. Submit a copy of manufacturer's product information and installation instructions.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the requirements of the applicable referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.
- B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications
- C. Tests: Unless otherwise specified, all material used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards.
- D. The CONTRACTOR shall perform all material tests at no additional costs to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR provided that the CONTRACTOR's schedule is not delayed for the

convenience of the ENGINEER. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

- A. All new RPVC tubing, PVC piping, fittings, couplings, and appurtenant equipment shall be free from defects of contamination.
- B. All materials of construction shall be suitable for use with the intended chemical service.

2.2 REINFORCED PVC (RPVC) TUBING

- A. All buried hypochlorite disinfection feed piping shall be RPVC tubing installed within PVC pipe conduit. PVC pipe conduit greater than 4-inches in diameter shall be as specified in Section 02597 – Poly Vinyl Chloride Pressure Pipe, Rubber Joints (AWWA C900 and C905 Modified). PVC pipe conduit less than 4-inches in diameter shall be Schedule 80 PVC pipe, as specified in Section 15060 – Polyvinyl Chloride Solvent Welded Pipe. Long radius elbows shall be PVC electrical sweeps with suitable water-tight connections to the main run pipe.
- B. Where double contained pipe is specified in the CONSTRUCTION DRAWINGS piping shall be RPVC tubing installed within PVC containment pipe. PVC pipe shall be as specified in Section 15060 – Poly Vinyl Chloride (PVC) Pipe.
- C. RPVC tubing shall be, flexible, PVC tubing with white polyester cord or nylon reinforcement embedded in transparent PVC walls. Tubing and containment pipe diameters shall be as indicated in the CONSTRUCTION DRAWINGS.
- D. Tubing shall be at least 65 Durometer hardness, rated for working pressure of 200 psi, with burst pressure twice as high as the working pressure. Temperature range of tubing shall be -5°F to 150°F.
- E. Compression fittings are acceptable if the resulting connections have a pressure rating equal to or greater than tubing pressure rating. In any event, maximum diameter of any element of a tube fitting shall not be greater than 1-inch.
- F. Tubing shall be continuous without splices within PVC conduit.

PART 3 EXECUTION

3.1 GENERAL

- A. Piping and its installation shall be in accordance with Section 15000 – Piping, General.

3.2 DELIVERY AND STORAGE

- A. All plastic materials shall be stored out of direct sunlight.

3.3 TESTING

- A. Testing shall be performed in accordance with the requirements of Section 15000 – Piping, General.

3.4 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 02200 – Earthwork.

3.5 INSTALLATION OF PIPELINES THROUGH CONCRETE STRUCTURES

- A. Pipe-wall penetrations in chemical containment areas shall be leakproof type; wall sleeves shall be HDPE with ring type anchor and waterstop; closures shall be modular mechanical type with interlocking, synthetic rubber links with 316 stainless steel pressure plate and hardware. Whenever a pipeline or any material terminates at or extends through a structural wall or sump, the CONTRACTOR shall install, in advance of pouring the concrete, the fitting or special casting required for the particular penetration. Contractor shall exercise care to ensure electrical insulation of the fitting or special casting from the rebar. A minimum separation of 3 inches shall be maintained.

END OF SECTION

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SECTION 15086 – PARSHALL FLUMES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install one (1) Parshall flume and all appurtenant work for open-channel flow measurement, complete and operable. The CONTRACTOR shall be responsible for coordinating with the MANUFACTURER to confirm installation requirements and dimensions.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AWWA
 - 1. Standard F101: Contact-Molded, Fiberglass-Reinforced Plastic Wash Water Troughs and Launderers.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 - Submittals.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions

6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

B. Warranty

1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.5 MANUFACTURERS SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01730, Operation and Maintenance Data, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection,
2. 0.5 person-days for functional and performance testing
3. 0.5 person-days for pre-startup training of OWNER's personnel.

PART 2 PRODUCTS

2.1 GENERAL – ME-HW-FLW1

- A. Basic Design: Full-length, molded, fiber glass-reinforced polyester Parshall flume liners shall be installed in the flume channels for measurement of raw sewage plant influent flow. Flumes shall be set in grout. Flumes shall be provided with an ultrasonic level sensing system with a Type 316 stainless steel mounting bracket for level sensing to measure, indicate, and transmit the flow through the channel.
- B. Schedule of Parshall Flumes: The CONTRACTOR shall provide the following Parshall flumes:

<u>Equip. Tag No.</u>	<u>Service</u>	<u>Low Flow mgd</u>	<u>Maximum Flow mgd</u>	<u>Size (in)</u>
ME-HW-FLW1	Screened Wastewater	0.25	13.0	18

2.2 MATERIALS OF CONSTRUCTION

- A. Flume: The flume insert shall be a full-length, molded, fiber glass-reinforced polyester liner fabricated in one piece from polyester resin, reinforced with glass mat. Not less than 30 percent (by weight) of the flume insert shall be reinforcement. The thickness of the walls shall not be less than 1/4-in. There shall be a sufficient number of locking clips or flanges to be an integral part of the liner to assure secure anchorage and correct alignment integral stiffeners shall be provided with sufficient structural strength to resist

all the stresses that occur during the shipping and installation of the flume. Temporary spreaders may be placed across the top of the flume. The flume shall be designed for trouble-free operation to produce metering heads to within 2 percent of its published rating curve. The CONTRACTOR shall furnish certified data, in the form of a curve or table, relating level to flow rate at 0.1-foot intervals. The inside surface of the flume shall be completely smooth and free from surface defects.

2.3 CONTROLS

- A. Level sensors, flow rate indicators, transmitters, and receivers shall be as specified in Section 13400, Instrumentation and Controls.

2.4 MANUFACTURERS

- A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized Parshall flumes for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the equipment and for coordination of design, assembly, and testing of the equipment described in this section.
- C. Manufacturers or Equal:
 - 1. Plasti-Fab.
 - 2. Warminster Fiberglass.
- D. Any use of substitute equipment shall not relieve the CONTRACTOR of providing a complete and operable system in complete conformance to the specifications, including all performance parameters and interfacing requirements.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 INSTALLATION

- A. The flumes shall be installed true and level, in accordance with the manufacturer's printed instructions. All interfaces of the flume and the adjacent concrete shall be flush and provide a smooth, continuous surface.

END OF SECTION

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SECTION 15180 – STRAINERS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide pipe strainers where indicated, complete and operable, in accordance with the Contract Documents.
- B. All strainers shall be of ample size, with the perforations suitable for each individual service, and designed for easy cleaning and removal of the strainer basket.

1.2 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished under this Section and in referenced Sections in accordance with the requirements of Section 01300 - Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 – Submittals, Product Data and Samples. CONTRACTOR shall submit the following:
 - 1. Construction details, sizes, dimensions, weights, materials, control diagrams, electric motor data, and pressure ratings, in accordance with Section 11000 - Equipment General.
- C. O & M Manuals: The CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Spare parts list: List of suggested spare parts to maintain the equipment in service for a period of 5 years.

1.3 QUALITY ASSURANCE

- A. Warranty: A written warranty shall be provided for the equipment specified in this section as required in Section – 01740 Warranty.

PART 2 PRODUCTS

2.1 STRAINERS (METAL BODY)

- A. Equipment Requirements: Strainers shall be of the Y-pattern or basket type, with flush connections, bronze bodies, a bottom blow off connection, and screwed ends for sizes 3-inch and smaller, and flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainers shall be of the same size as the entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.
- B. Strainers shall have tapped and plugged blow off connections and all the required piping to route blow off flows to the nearest drain, as indicated in the contract documents.
- C. Screens: Unless otherwise indicated or required by the service fluid, the screens shall be of type 316 stainless steel construction, easily removable, with perforation size of 1/64 –inch diameter or closest mesh equivalent.
- D. Spare parts: One spare set of screens shall be provided.
- E. Manufacturers, or Equal:
 - 1. Flexicraft.
 - 2. Sterling.

2.2 STRAINERS (BOTTOM DUMP MODEL)

- A. Where indicated in the Drawings, strainer shall be the bottom dump type with flush connections, stainless steel body, a 2-inch drain connection at the bottom of the strainer which shall allow for flushing of the inside of the screening elements. The bottom drain connection shall connect to a 2-inch drain line with a 2-inch ball valve.
- B. Strainer shall have screwed ends for sizes 3-inch and smaller, and flanged ends for sizes greater than 3-inch. They shall be designed for not less than 250 psi working pressure in sizes 3-inch and smaller, and 125 psi working pressure in sizes over 3-inch. Strainer outlet piping shall be of the same size as the entering pipe and the screens shall have a free area of not less than three times the cross-sectional area of the pipe.
- C. If the outlet pipe is offset in the vertical direction from the entering pipe, the CONTRACTOR shall provide all the necessary elbows and fittings to route the outlet pipe back up to the same vertical plane as the entering pipe. Piping and fittings shall be of the same type as the entering pipe.
- D. Screens, spare parts and manufacturers shall be as specified for the metal body strainers.

2.3 STRAINERS (PLASTIC BODY)

- A. Equipment Requirements: Strainers shall be of the Y-pattern type with removable screen, cap, and EPDM or Viton O-ring seal, and PVC body with screwed ends, rated for the following pressures at 70 degrees F. The O-ring seals shall be as follows, unless indicated otherwise; Viton shall be used for sodium hypochlorite and polymer; EPDM shall be used for sodium bisulfite; and Buna N (nitrile) shall be used for alum.
 - 1. 150 psi for sizes 1/2 to 1 inch
 - 2. 90 psi for sizes 1-1/2 to 2 inches
 - 3. 60 psi for sizes 3 to 4 inches
- B. Screen: The screens shall be of PVC, with a free area of twice the cross-sectional area of the pipe and 1/32-inch perforations.
- C. Manufacturers, or Equal:
 - 1. ASAHI/AMERICA
 - 2. Hayward Industrial Products, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. The requirements of Section 11000 – Equipment, General apply to this section.
- B. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions.
- C. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good any and all damage. During shipping the rotating elements shall be suitably supported or disassembled to protect bearings.
- D. Where necessary, heavy parts or machines shall be mounted on skids or shall be crated, and any articles or materials that might otherwise be lost shall be boxed or wired in bundles and plainly marked for identification. The gross weight shall be clearly marked on all boxes or skidded equipment packages exceeding 200 pounds. All parts exceeding 200 pounds gross weight shall be prepared for shipment so that slings for handling by a crane may be readily attached while the parts are on the car or transport truck. Boxed parts, where it is unsafe to attach slings to the box, shall be packed with slings attached to the part, the slings to project through the box or crate so that attachment to the hoisting equipment can be readily made.

- E. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
- F. All parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the equipment is ready for operation.
- G. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.
- H. The finished surfaces of all exposed flanges shall be protected by strong wooden blind flanges.

3.2 INSTALLATION

- A. Automatic strainers shall be installed in accordance with the Manufacturer's printed recommendations and approved procedures submitted with the shop drawings and as indicated.
- B. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation.
- C. Unless otherwise indicated, strainers shall be provided ahead of any control valves, regulators, steam and condensate traps, and where shown, and shall be preceded by shut-off valves.

3.3 TESTING

- A. General: testing in accordance with Section 01650 Facility Start Up.
- B. Factory testing:
 - 1. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture, unless specified otherwise.
 - 2. The following tests shall be conducted on each indicated automatic strainer and test data shall be submitted:
 - a. Hydrostatic test as testing with the applicable piping system.

END OF SECTION

SECTION 15200 – VALVES, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- C. Single Manufacturer: Where two or more valves of the same type or size are required, the valves shall be furnished by the same manufacturer. Valve and valve actuators shall be provided by the valve supplier.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216	Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service
ASTM A351	Specification for Steel Castings, Austenitic, for High-Temperature Service
ASTM A395	Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A536	Specification for Ductile Iron Castings
ASTM A515	Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B584	Specification for Copper Alloy Sand Castings for General Applications.

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01300- Submittals.
- B. Shop Drawings: Shop drawings shall contain the following information:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and Specification Section number.
2. Complete information on valve actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.
3. Cavitation limits for all control valves.
4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
5. Complete wiring diagrams and control system schematics.
6. Valve Labeling: A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.

C. Certifications:

1. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.
2. Prior to shipment, the Contractor shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, and ASTM.
3. Manufacturer's certification of proper installation.
4. Contractor's certification of satisfactory field testing.

5.

D. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

E. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.

1.4 QUALITY ASSURANCE

A. Valves, gates, and actuators are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.

1.5 WARRANTY

- A. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

1.6 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. As specified in each pump section, a manufacturer/supplier's representative shall be present at the job site for assistance during installation, equipment startup, testing, and training.

1.7 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section.

PART 2 PRODUCTS

2.1 GENERAL

- A. All valves and gates shall be new and of current manufacture. All shut-off valves 6-inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators
- B. VALVE SCHEDULE
 - 1. The valve schedule is located at the end of this specification.
 - 2. Notes:
 - a. Valves included and specified with package systems are not included in this schedule. Refer to the individual package system specifications.
 - b. Valve schedule includes manual valves 4 Inches and above.
 - 3.

2.2 VALVE COMPONENTS – GENERAL MATERIAL/PRODUCT

- A. General: All materials shall be suitable for the intended application. Materials not specified 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. Unless otherwise specified, valve and actuator bodies shall conform to the following requirements:
 - 1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A48 - Specification for Gray Iron Castings, Class 30, or to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. Ductile Iron: ASTM A536 - Specification for Ductile Iron Castings, or to ASTM A395 - Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 3. Steel: ASTM A216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A515 - Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.
 4. Bronze: ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
 5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A351 - Specification for Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
 - 6.
- B. Bodies: Valve bodies shall be cast, forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. All welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.
- C. Flanges: Valve flanges shall be in accordance with ANSI B16.1, B 16.5 and ASTM A126, unless otherwise indicated. For small diameter pipe, valve flanges shall be in accordance with industry standards. CONTRACTOR is responsible for coordinating pipe and valve flanges to ensure that they are compatible.
- D. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- E. Valve Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Where subject to dezincification, bronze valve stems shall conform to ASTM B62, containing not more than 5 percent of zinc or more than 2 percent of aluminum, with a minimum tensile strength of 414 MPa (60,000 psi), a minimum yield strength of 276 MPa (40,000 psi), and an elongation of at least 10 percent in 50 mm (2 inches.) Where dezincification is not a problem, bronze conforming to ASTM B584 may be used.
- F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.

- G. Valve Operators: All valve operators, regardless of type, shall be manufactured, installed, adjusted, and tested by the valve manufacturer at the manufacturer plant. All valves shall open counter-clockwise unless otherwise shown or specified.
- H. Position Indicators: All shut-off valves 14-inch and larger, shall have operators with position indicators. Where buried, these valves shall be provided with valve boxes and covers containing extensions and position indicators.
- I. Valve Boxes and Covers: Valve box and cover shall be cast iron. Where valve boxes house position indicators, the valve box shall conform to the requirements of the position indicator manufacturer. All covers shall be imprinted as shown on the Drawings.
- J. Valves shall be furnished complete with the accessories required to provide a functional system.
- K. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 15201 – Valve and Gate Actuators for all electric motor-actuated valves. All valve and gate actuators on the project shall be of the same manufacturer.
- L. Valve labeling: Except when such requirement is waived by the Engineer in writing, a label shall be provided on all shut-off valves and control valves except for hose bibs. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, as indicated in Section 15005 - Piping Identification Systems, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.
- M. Valve Marking: All valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.3 SPARE PARTS

- A. Where indicated, the Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. All spare parts are intended for use by the Owner, only after expiration of the guarantee period.

2.4 PROTECTIVE COATING

- A. The exterior surfaces of all valves and the wet interior surfaces of all ferrous valves of sizes 4 inches and larger shall be coated in accordance with Section 09960 – Protective Coatings. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- B. Where surfaces have been shop painted but have been damaged during delivery, storage or assembly, or where shop coats have deteriorated, these surfaces shall be properly cleaned and retouched or repainted with matching paint.

2.5 BUTTERFLY VALVES - AWWA

- A. General: Butterfly valves for water working pressures up to 1,030 KPa (150 psi) shall conform to ANSI/AWWA C504, except for lay length and shaft diameters. Valves are subject to the following requirements. Valves shall be of the size and class indicated. Wafer valves shall be class 150B. The interior passage of butterfly valves shall not have any obstructions or stops. Valves 750 mm (30-inches) and larger shall have a wide diameter not smaller than 38 mm (1 ½ - inches) less than the normal valve size. The inside diameter shall be measured at the inside diameter of the seat or the smallest inside diameter location. Unless otherwise indicated, all valves shall open counter-clockwise.
- B. Materials of Construction
1. Body: The valve body shall be constructed of ASTM A536 ductile iron or ASTM A126 Class B cast iron and shall be flanged type or lugged type. Flanged valves shall have ANSI 125-lb flanges.
 2. Disc: The disc shall be of ductile iron, ASTM A536 Grade 65-45-12, Nylon 11 Coated or ASTM A126 Class B cast iron. The disc seating edge shall be solid Type 316 stainless steel. The disc shall be securely attached to the valve using Type 304 stainless steel taper pins.
 3. Seat: Seats for valves smaller than 24" shall be bonded to the body or clamped to the disc edge. The disc-mounted seats shall be retained on the disc by means of an ASTM A167 or A240 Type 304 stainless steel ring and cap screws. The seats shall be positively clamped or bonded into the disc or body of the valve. The seat shall line the body of the valve and shall be food grade EPDM. Seats shall be field replaceable. The seat design of the 24" or larger valves shall allow for replacement and field adjustment of the full 360 degree circumference without dismantling the operator, disc, or shaft and without removing the valve from the pipeline.
 4. Shaft: The shaft shall be of one-piece construction, of ASTM A276 or A240 Type 304 stainless steel. The shaft shall be provided with a machined groove or chamfer on the top end of the shaft, indicating the precise disc position on the shaft. Shaft diameters shall be in compliance with AWWA C504.
 5. Bearings: Bearings shall be per AWWA C504 requirements. Bearings shall be Teflon lined with non-metallic fiberglass composite backing and shall be permanently lubricated.
 6. Shaft Seals: Shaft seals shall be designed for use with standard split-V type packing with a minimum of four sealing rings.
 7. Actuator: Unless otherwise indicated, the valve actuators shall be of the worm gear type or traveling nut type, in accordance with Section 15201 - Valve and Gate Actuators, designed for the full bi-directional rating of the valve.
 8. Manual Actuators: Actuators shall conform to ANSI/AWWA C540, subject to the following requirements. Unless otherwise indicated, all manually-actuated

butterfly valves shall be equipped with a hand wheel or chain operator as shown or indicated. All buried valves shall be equipped with a 2-inch square actuating nut and ground-level position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30 inches in diameter and larger. Manual actuators shall allow for positive throttling and locking in any position from open to closed.

9. Worm Gear Actuators: All submerged and buried valves shall be equipped with worm-gear or traveling nut type actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

10.

- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.

- D. Manufacturers, or Equal:

1. De Zurik Corporation
2. Henry Pratt Company
3. M & H Valve Company
4. Mueller Company
- 5.

2.6 METAL BALL VALVES (4-INCH AND SMALLER)

- A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inch shall have actuators in accordance with Section 15201 - Valve and Gate Actuators.

- B. Materials of Construction

1. Body: All metal ball valves up to 1-1/2-inch (incl.) in size shall have bronze or carbon steel 2-or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inch to 4-inch in size shall have bronze or carbon steel 2-or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi, unless otherwise indicated.
2. Balls: The balls shall be solid chrome plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.
3. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.
4. Seats: The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.

C. Manufacturers, or Equal:

1. Conbraco Industries, Inc. (Apollo).
2. ITT Engineered Valves.
3. Neles-Jamesbury, Inc.
4. NIBCO, Inc.
5. Watts Regulator
6. Worcester Controls

2.7 PLASTIC BALL VALVES

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or polyvinylidene fluoride (PVDF), as recommended by the Manufacturer for the specific application. All valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators, unless otherwise indicated. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC, with decreasing ratings for higher temperatures and other plastics.

B. Materials of Construction

1. Body: All plastic ball valves shall have union ends or flanged ends to mate with ANSI B16.5, class 150, for easy removal.
2. Balls: The balls shall have full size ports and Teflon seats. All body seals, union O-ring seals, and stem seals shall be corrosion resistant for the fluid and field application.

C. Manufacturers, or Equal:

1. ASAHI-America.
2. George Fischer, Inc.
3. NIBCO Inc., (Chemtrol)
4. Watts Regulator

2.8 PLASTIC BODY DIAPHRAGM VALVES

A. Materials of Construction: Unless otherwise indicated, valve bodies shall be of PVC, CPVC, PP, or PVDF construction, as best-suited for each individual service, with union ends, screwed ends, socket-welded ends, or flanged ends to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, drilled to 150 lb. dimensions, as indicated. The valve bonnets shall be flanged and of PVC, PP, or PVDF construction. The valve stem shall be of carbon steel or stainless steel with brass, bronze, or cast-iron sleeve and a compressor of aluminum, brass, bronze, or cast-iron. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves

in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 104 degrees F, diminishing to not less than 50 psi for larger sizes.

- B. Diaphragm: The diaphragms of all valves shall be of the best-suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be Teflon. All diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.
- C. Manufacturers, or Equal:
 - 1. ASAH/ America
 - 2. George Fischer, Inc. (+GF+)
 - 3. ITT Dia-Flo (Grinnell)
 - 4. Mc Canna, Inc.

2.9 METAL-SEATED GATE VALVES (3-INCH AND LARGER)

- A. General: Metal-seated gate valves for water and sewage service shall conform to ANSI/AWWA C500 - Metal-Seated Gate Valves for Water Supply Service. The design working water pressure shall be 200 psig for valves 12 inches and smaller and 150 psig for larger valves. The valves may be of the double-disc type for tighter shut-off, or of the solid-wedge type, with rising or non-rising stem. For sewage or fluids containing solids, an outside thread shall be used.
- B. Materials of Construction: The valve bodies shall be of cast iron conforming to ASTM A126 - Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, or ductile iron conforming either to ASTM A395 - Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures, or to ASTM A536 - Specification for Ductile Iron Castings, with flanged, bell and spigot, or mechanical joint-ends as indicated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of ANSI/AWWA C500. Valves 14-inch and larger installed in vertical pipes shall be fitted with bronze slides, tracks, rollers, and scrapers to assist the travel of the gate assembly. Gate valves 14-inch and larger shall be furnished with bypass assemblies.
- C. Actuators: Unless otherwise indicated, all gate valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators.
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
 - 1. American Flow Control
 - 2. Clow Valve Co.

3. Crane Valves
4. Kennedy Valve
5. M & H Valve Company
6. Milwaukee Valve Company, Inc.
7. Mueller Company (Grinnell Corp.)
8. Stockham Valves and Fittings

2.10 KNIFE-GATE VALVES (2- TO 96-INCH)

- A. General: Knife-gate valves shall be of the flanged or wafer design, with raised face and resilient seats for positive seating. The valves shall be rated for tight shut-off at the following pressures:
 1. Valve Sizes 4- to 12-Inch: 150 psi (bi-directional).
 2. Valve Sizes Larger Than 12-Inch: 50 psi.
- B. Materials of Construction: Wetted parts shall be constructed of Type 316 stainless steel and the gates shall be finish-ground on both sides to prevent packing or seat damage. Valves 2- to 12-inch in size shall be furnished with cast stainless steel bodies; valves 14-inch and larger shall have semi-steel bodies with stainless steel linings. The valve stem shall be of stainless steel with a long life packing.
- C. Actuators: Knife-gates shall have outside-screw and yoke-rising stems with manual handwheel actuators, unless otherwise indicated, in accordance with Section 15201 - Valve and Gate Actuators.
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
 1. DeZurik Corporation
 2. Fabri-Valves
 3. Rovang, Inc.

2.11 RESILIENT-SEATED GATE VALVES (3- TO 16-INCH)

- A. General: Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the Engineer.
- B. Materials of Construction: Resilient-seated gate valves shall conform to ANSI/AWWA C509 - Resilient-Seated Gate Valves for Water and Sewerage Systems. The valves shall be suitable for a design working water pressure of 200 psig, with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber-coated. Body

and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 2 of ANSI/AWWA C509. The stem, stem nuts, glands, and bushings shall be of bronze, with the stem seal per ANSI/AWWA C509.

- C. Actuators: Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 15201 - Valve and Gate Actuators.
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
 - 1. American Flow Control
 - 2. Clow Valve Co.
 - 3. Kennedy Valve
 - 4. M & H Valve Company
 - 5. Mueller Company (Grinnell Corp.)
 - 6. Stockham Valves and Fittings

2.12 GATE VALVES (SMALLER THAN 3-INCH)

- A. General: Gate valves, smaller than 3-inch, for general purpose use, shall be non-rising stem, heavy-duty type for industrial service, with screwed or soldered ends to match the piping. All valves shall have a pressure rating of minimum 125 psi steam, and 200 psi coldwater, unless otherwise indicated.
- B. Materials of Construction
 - 1. Body: The bodies shall have union bonnets of bronze conforming to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
 - 2. Stems: The stems shall be of bronze conforming to ASTM B62, or ASTM B371 - Specification for Copper-Zinc-Silicon Alloy Rod. The solid wedges shall be of bronze conforming to ASTM B62.
 - 3. Handwheels and stem seals: The valves shall have malleable iron handwheels, unless otherwise indicated, and stem seals shall be of Teflon-impregnated or other acceptable non-asbestos packing.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 - Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. Crane Company
 - 2. Milwaukee Valve Company

3. Wm. Powell Company
4. Stockham Valves and Fittings
5. Walworth Company

2.13 PLASTIC GATE VALVES (1-1/2- TO 14-INCH)

- A. Construction: Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined plugs for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a coldwater pressure rating of 150 psig for sizes 1-1/2- through 8-inch, 110 psig for size 10-inch, and 70 psig for sizes 12- and 14-inch.
- B. Actuators: Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 15201 - Valve and Gate Actuators.
- C. Manufacturers, or Equal:
 1. ASAHI/America

2.14 LUBRICATED PLUG VALVES (1/2-INCH TO 36-INCH)

- A. General: Lubricated plug valves shall be the tapered plug top-entry type, with flanged ends for sizes 3-inch and larger, and flanged or screwed ends for smaller valves, as indicated. The valve shall be rated for ANSI Class 150 or as indicated, between service temperatures of minus 20 to plus 100 degrees F.
- B. Materials of Construction
 1. Body and Top Plate: The body and top plate shall be of cast steel conforming to ASTM A216 - Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or other acceptable cast or forged steel.
 2. Plug: The plug shall be of steel or cast iron and the stem shall be of stainless steel or alloy steel, with weather seal and Teflon impregnated packing. The valve body and plug shall have smoothly-finished water passages free from sharp corners when the plug is in the wide-open position.
 3. Sealant System: The valves shall be provided with fittings designed to feed a sealant through a check-valve protected passage in the stem, through the side, or through a stainless steel tube for worm-gear actuated or buried valves. There shall be ducts or grooves in the face of the plug to insure the maintenance of a closed, pressurized sealant system between all contact surfaces of moving parts. All surfaces of the plug shall be coated with a dry film lubricant, such as polyfluoride or equal, to suit the service, permanently bonded to the metal surfaces. Sealant for LP gas service shall be the Manufacturer's recommended type. The plug shall be held toward the seat by factory-adjusted gland assemblies set for proper sealing and operating

torque. The gland assemblies shall be adjustable from the valve exterior and shall utilize either spring washers or gland deflection to allow plug unseating when pressurized sealant is injected.

- C. Actuators: Unless otherwise indicated, valves 3-inch and smaller shall be lever-actuated; larger valves shall be equipped with manual worm-gear actuators. Valve actuators shall be in accordance with Section 15201 - Valve and Gate Actuators.
- D. Lubricating Gun: The Contractor shall furnish a manual lubricating gun for lubricated plug valves in sizes up to 6-inch, inclusive. For larger valves, the Contractor shall furnish a pneumatically-operated lubricating gun and a manual lubricating gun. For installations of more than 6 lubricated plug valves, the number of guns furnished shall be doubled. The guns shall be of the same Manufacturer as the valves. Guns shall each be equipped with flexible connectors, pressure gauge, safety valve, and be furnished in labeled tool boxes with operating instructions.
- E. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 09960 – Protective Coatings.
- F. Manufacturers, or Equal:
 - 1. Nordstrom Valves, Inc.
 - 2. Serck Audco Valves

2.15 ECCENTRIC PLUG VALVES (1/2-INCH TO 72-INCH)

- A. General: Eccentric plug valves shall be of the non-lubricated, eccentric plug design.
- B. Performance: Unless otherwise indicated, all eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.
- C. Materials of Construction
 - 1. Body: Valve body shall be cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings with ANSI 125 lb. flanged ends for valves 3-inch and larger, and screwed or flanged ends for smaller sizes.
 - 2. Plugs and Shafts: The plugs and shafts shall be of solid cast iron or ductile iron conforming to ASTM A536-Specification for Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service.
 - 3. Seats: The seats shall be of nickel or stainless steel welded to the body. Eccentric plug valves for digester gas service shall have Type 316 stainless steel plugs and suitable resilient seating of Viton.

4. Stem Seal: Shall be of a self-adjusting elastomer U-cup design. The stem seal elastomer shall be the same as the plug elastomer. O-rings are not acceptable.
5. Bearings: All top and bottom shaft bearings shall be of permanently lubricated stainless steel, or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals o-ring style grit seals are unacceptable.
6. Port Flow Way: 2-1/2" to 12", the flow way shall be round, 100 percent area, full port design. Valves greater than 12", the flow way shall be round or rectangular, 100 percent area full port design. Flow coefficients for 2-1/2" valves to 36" shall comply with the following table:

7.	8. 2 1/2"	9. 3"	10. "	11. "	12. "	13. "	14. 0"	15. 2"
16. Mini mum Cv	17. 60	18. 35	19. 120	20. 000	21. 359	22. 182	23. 073	24. 366
25.	26.	27.	28.	29.	30.	31.	32.	33.
34.	35. 4"	36. 6"	37. 8"	38. 0"	39. 4"	40. 0"	41. 6"	42.
43. Mini mum Cv	44. ,505	45. ,365	46. 1,196	47. 6,131	48. 1,343	49. 6,445	50. 7,871	51.

D.

- E. Actuators: Unless otherwise indicated, all eccentric plug valves 3-inch and smaller shall have operating levers; all larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 15201 - Valve and Gate Actuators.
- F. Protective coating: The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance with Section 09960 – Protective Coatings.
- G. Manufacturers, or Equal:
 1. Milliken
 2. DeZurik Corporation
 3. Val Matic - Cam Centric

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. The Contractor shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.
- B. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

- A. General: All valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as indicated. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe. Where applicable, valves shall be installed with the seat upstream.
- B. Access: All valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.
- C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 TESTING

- A. General: All valve testing shall be in accordance with applicable standards of AWWA, ANSI, and ASTM.
- B. Factory Testing: As a minimum, unless otherwise indicated, each valve body 4 inches and larger shall be tested hydrostatically to 1.5 times its rated 100 degrees F design water-working pressure, for a period of 5 minutes, without showing any leaks or loss of pressure. In addition, each valve 4 inches and larger shall undergo a functional test to demonstrate satisfactory operation throughout its operating cycle, and a closure test at rated 100 degrees F water-working pressure for a period of 5 minutes to demonstrate tight shut-off. Stem seal leakage shall not be a cause for rejection. All valves 3 inches and smaller shall undergo the Manufacturer's standard test.
- C. Performance Testing: All valves shall be tested with the piping system in accordance with Section 02640 – Pipeline Testing and Disinfection. Field testing will be witnessed by the Engineer. The Contractor shall furnish three days advance notice of field testing.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Valve Schedule

END OF SECTION

Valve Schedule

LOCATION	VALVE NO.	DESCRIPTION	VALVE TYPE	ACTUATOR TYPE	SIZE (IN)	NOTES
Influent	INF-PVLV08-01	Ft. Baker Sewer Plug Valve	Plug Valve	Buried	08	Full Port
Influent	INF-KVLV20-01	Beach Forcemain Knife Gate Valve 1	Knife Gate Valve	Buried	16	
Influent	INF-KVLV20-02	Beach Forcemain Knife Gate Valve 2	Knife Gate Valve	Buried	16	
Headworks	HW-PVLV24-01	Plant Influent Plug Valve	Plug Valve	Buried	24	Full Port
Headworks	HW-PVLV18-01	Headworks Bypass Plug Valve 1	Plug Valve	Buried	18	Full Port
Headworks	HW-PVLV18-02	Headworks Bypass Plug Valve 2	Plug Valve	Buried	18	Full Port
Headworks	SC-EQP1-MVLV4-01	Screen Channel 1 Mud Valve	Mud Valve	Operating nut	4	
Headworks	SC-EQP2-MVLV4-01	Screen Channel 2 Mud Valve	Mud Valve	Operating nut	4	
Headworks	SC-BAR1-MVLV4-01	Screen Bypass Channel 1 Mud Valve	Mud Valve	Operating nut	4	
Grit Pumping	GRT-PMP1-PVLV04-01	Grit Pump 1 Suction Plug Valve	Plug	Manual	4	Full Port
Grit Pumping	GRT-PMP2-PVLV04-01	Grit Pump 2 Suction Plug Valve	Plug	Manual	4	Full Port
Grit Pumping	GRT-PMP1-PVLV04-02	Grit Pump 1 Discharge Plug Valve	Plug	Manual	4	Full Port
Grit Pumping	GRT-PMP2-PVLV04-02	Grit Pump 2 Discharge Plug Valve	Plug	Manual	4	Full Port
Grit Pumping	GRT-PMP1-CVLV04-01	Grit Pump 1 Check Valve	Swing Check	N/A	4	
Grit Pumping	GRT-PMP2-CVLV04-01	Grit Pump 2 Check Valve	Swing Check	N/A	4	
Equalization Pumping	EQ-PMP1-AVLV10-01	Equalization Pump 1 Air Release Valve	Air release valve	N/A	10	
Equalization Pumping	EQ-PMP1-CVLV10-01	Equalization Pump 1 Check Valve	Swing Check valve	N/A	10	
Equalization Pumping	EQ-PMP1-PVLV10-01	Equalization Pump 1 EQ Suction Plug Valve	Plug valve	Motorized	10	Full Port

LOCATION	VALVE NO.	DESCRIPTION	VALVE TYPE	ACTUATOR TYPE	SIZE (IN)	NOTES
Equalization Pumping	EQ-PMP1-PVLV10-02	Equalization Pump 1 PE Suction Plug Valve	Plug valve	Motorized	10	Full Port
Equalization Pumping	EQ-PMP1-PVLV10-03	Equalization Pump 1 Discharge Plug Valve	Plug valve	Manual	10	Full Port
Equalization Pumping	EQ-PMP2-AVLV10-01	Equalization Pump 2 Air Release Valve	Air release valve	N/A	10	
Equalization Pumping	EQ-PMP2-CVLV10-01	Equalization Pump 2 Check Valve	Check valve	N/A	10	
Equalization Pumping	EQ-PMP2-PVLV10-01	Equalization Pump 2 EQ Suction Plug Valve	Plug valve	Motorized	10	Full Port
Equalization Pumping	EQ-PMP2-PVLV10-02	Equalization Pump 2 PE Suction Plug Valve	Plug valve	Motorized	10	Full Port
Equalization Pumping	EQ-PMP2-PVLV10-03	Equalization Pump 2 Discharge Plug Valve	Plug valve	Manual	10	Full Port
Equalization Pumping	EQ-PVLV10-01	Equalization Pumping Discharge Plug Valve	Plug valve	Manual Chain	10	Full Port
Equalization Pumping	EQ-PVLV10-02	Equalization Pumping Discharge Plug Valve	Plug valve	Manual Chain	10	Full Port
Equalization Pumping	EQ-PVLV10-03	Equalization Pumping Discharge Plug Valve	Plug valve	Manual Chain	10	Full Port
Equalization Pumping	EQ-PVLV10-04	Equalization Pumping Discharge Plug Valve	Plug valve	Motorized	10	Full Port, To Headworks Return Box
Equalization Pumping	EQ-PVLV10-05	Equalization Pumping Discharge Plug Valve	Plug valve	Motorized	10	Full Port, To FFR Distribution Box
Primary Sludge Pumping	PC2-PMP1-PVLV04-01	Primary Sludge Pump 1 Suction Plug Valve	Plug valve	Manual	4	Full Port, From Scum Pit
Primary Sludge Pumping	PC2-PMP1-PVLV04-02	Primary Sludge Pump 1 Suction Plug Valve	Plug valve	Manual	4	Full Port, From Sludge Sump
Primary Sludge Pumping	PC2-PMP2-PVLV04-01	Primary Sludge Pump 2 Suction Plug Valve	Plug valve	Manual	4	Full Port, From Scum Pit
Primary Sludge Pumping	PC2-PMP2-PVLV04-02	Primary Sludge Pump 2 Suction Plug Valve	Plug valve	Manual	4	Full Port, From Sludge Sump
Primary Sludge Pumping	PC2-PMP1-CVLV04-01	Primary Sludge Pump 1 Discharge Check Valve	Check valve	N/A	4	

LOCATION	VALVE NO.	DESCRIPTION	VALVE TYPE	ACTUATOR TYPE	SIZE (IN)	NOTES
Primary Sludge Pumping	PC2-PMP1-PVLV04-03	Primary Sludge Pump 1 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping	PC2-PMP2-CVLV04-01	Primary Sludge Pump 2 Discharge Check Valve	Check valve	N/A	4	
Primary Sludge Pumping	PC2-PMP2-PVLV04-03	Primary Sludge Pump 2 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping	PC2-PMP1-PVLV04-04	Primary Sludge Pump 1 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping	PC2-PMP2-PVLV04-05	Primary Sludge Pump 2 Discharge Bypass	Plug valve	Manual	4	Full Port
Primary Sludge Pumping	PC2-PMP2-PVLV04-04	Primary Sludge Pump 2 Discharge Plug Valve	Plug valve	Manual	4	Full Port
Primary Sludge Pumping	PC2-PMP2-PVLV04-05	Primary Sludge Pump 2 Discharge Bypass	Plug valve	Manual	4	Full Port
Primary Sludge Pumping	PC2-PVLV06-01	Primary Clarifier Drain Valve	Plug	Buried	4	Full Port, Valve located off of the 6" Primary Sludge line from the bottom of the clarifier
Primary Effluent from PC2	PC2-KVLV16-01	Primary Effluent from PC2	Knife Gate Valve	Manual	16	
Primary Effluent from PC2	PC2-KVLV16-02	Primary Effluent from PC2	Knife Gate Valve	Manual	16	
FFR Pumping	FFR-PMP1-CVLV12-01	FFR Pump 1 Discharge Check Valve	Swing Check	N/A	12	
FFR Pumping	FFR-PMP2-CVLV12-01	FFR Pump 2 Discharge Check Valve	Swing Check	N/A	12	
FFR Pumping	FFR-PMP3-CVLV12-01	FFR Pump 3 Discharge Check Valve	Swing Check	N/A	12	
Fixed Film Reactors	FFR1-KVLV10-01	FFR 1 Isolation Valve	Knife Gate Valve	Manual	10	
Fixed Film Reactors	FFR2-KVLV10-01	FFR 2 Isolation Valve	Knife Gate Valve	Manual	10	
Filter Feed Pumping	FIL-PMP1-CVLV10-01	Filter Feed Pump 1 Check Valve	Ball Check	N/A	10	
Filter Feed Pumping	FIL-PMP1-BFLV10-01	Filter Feed Pump 1 Butterfly Valve	Butterfly valve	Manual	10	

LOCATION	VALVE NO.	DESCRIPTION	VALVE TYPE	ACTUATOR TYPE	SIZE (IN)	NOTES
Filter Feed Pumping	FIL-PMP2-CVLV10-01	Filter Feed Pump 2 Check Valve	Ball Check	N/A	10	
Filter Feed Pumping	FIL-PMP2-BFLV10-01	Filter Feed Pump 2 Butterfly Valve	Butterfly valve	Manual	10	
Filter Feed Pumping	FIL-PMP3-CVLV10-01	Filter Feed Pump 3 Check Valve	Ball Check	N/A	10	
Filter Feed Pumping	FIL-PMP3-BFLV10-01	Filter Feed Pump 3 Butterfly Valve	Butterfly valve	Manual	10	
Filters	FIL-BFLV10-01	Filter Feed Pump Station Return Valve	Butterfly valve	Motorized	10	
Filters	FIL-BFLV16-01	Filter Flow Meter Isolation Butterfly Valve	Butterfly valve	Manual	16	
Filters	FIL-BFLV12-02	Filter Flow Meter Bypass Butterfly Valve	Butterfly valve	Manual	12	
Filters	FIL1-BFLV16-01	Filter 1 Isolation Butterfly Valve	Butterfly valve	Manual	16	
Filters	FIL2-BFLV16-01	Filter 2 Isolation Butterfly Valve	Butterfly valve	Manual	16	
Filters	FIL1-BFLV16-02	Filter 1 Isolation Butterfly Valve	Butterfly valve	Manual	16	
Filters	FIL1-BFLV14-01	Filter 1 Effluent Butterfly Valve	Butterfly valve	Manual	14	
Filters	FIL2-BFLV14-01	Filter 2 Effluent Butterfly Valve	Butterfly valve	Manual	14	

SECTION 15201 – VALVE AND GATE ACTUATORS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and gates, except where otherwise indicated in the Contract Documents.
- C. Single Manufacturer: Where two or more valve or gate actuators of the same type or size are required, the actuators shall all be produced by the same manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/AWWA C540	AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates AWWA
AWWA C500	Metal-Seated Gate Valves for Water Supply Service

1.3 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01300 - Submittals, and Section 15200 - Valves, General.
- B. Shop Drawings: Shop Drawings of all actuators shall be submitted together with the valve and gate submittals as a complete package in accordance with Section 15200 - Valves, General. Complete wiring diagrams shall be provided for electric actuators.
- C. Certifications: Manufacturer's certificate of compliance that equipment furnished meet requirements of this specification.
- D. O & M manuals: O&M manuals shall be submitted in accordance with Section 15200 - Valves, General.
- E. Electrical and Control Submittals
 - 1. Provide complete information on control stations and valve actuators. Provide a bill of materials including tag numbers.
 - 2. Include complete information on electric power and interconnection requirements.
 - 3. Provide complete information on signal inputs and outputs: discrete (contact closures), and analog (4-20 milliamp signals).
 - 4. Electrical drawings and data shall be complete, shall represent the

equipment proposed for this project, and shall meet the applicable requirements of Section 16000 - Requirements for Electrical Work, and Section 13400 - Instrumentation and Controls. Drawings and data shall be adequate to demonstrate that the equipment meets the requirements of the Contract Drawings and Specifications, and also to be used by the Owner for operation, maintenance, and troubleshooting.

5. Provide electrical schematic diagrams and wiring diagrams as described in Section 16000 - Requirements for Electrical Work. They shall include interface wiring between actuators and control stations and other items on this project. Electrical schematic diagrams shall show circuits and device elements in ladder-diagram form without regard to physical location. Wiring diagrams shall show the connections and physical relationship of electrical devices and apparatus in circuits or groups of circuits within each actuator or control station.
6. For electrical schematic and wiring diagrams, manufacturer's standard drawings may be used, provided that they show the information required and are annotated to reflect the configuration for this project. For example, equipment numbers and descriptions unique to this project should be used, options not included should be stricken, signal interfaces with systems external to the actuators and control stations should be marked up to depict the actual interfaces on this project. Information and detail should be added to meet the requirements above, and other standard and optional provisions should be annotated to match this project.
7. Electrical drawings and data shall be identified with the device tag number and/or equipment number as shown on the Contract Documents, or otherwise shown.
8. Field Wiring Interconnection Diagram:
 - a. As described in Section 16000 - Requirements for Electrical Work, participate in the development of field wiring interconnection diagram(s). Provide detailed information showing termination provisions.

1.4 QUALITY ASSURANCE

- A. Pneumatic, hydraulic, or electric actuators are to be engineered and manufactured under a Manufacturer's written Quality Assurance program. The Quality Assurance program is to be in effect for at least (5) years, to include a written record for periodic internal and external audits to confirm compliance with such program.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Field Adjustments:

1. Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.
2. A Manufacturer's representative for electric operators shall be present at the job site for a minimum of two man days, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Where applicable, the Valve Manufacturer shall be responsible for furnishing the electric valve actuators. To the extent practical, valve actuators for the entire project shall be furnished by a single Actuator Manufacturer. The Valve Manufacturer shall coordinate with the Contractor to furnish actuators by the selected Actuator Manufacturer. Where the single Actuator Manufacturer's equipment is not compatible with a Valve Manufacturer's equipment, the Valve Manufacturer may use an alternative actuator upon approval by the Engineer. Valve operation shall not be compromised due to valve and/or actuator compatibility. The Valve Manufacturer is responsible for providing a properly operating valve system.
- B. The Contractor shall coordinate with all valve and gate manufacturers to ensure that all electric operators supplied are of the same manufacturer. The intent is to receive the same make and Manufacturer for all motor operators, all valves of a specific type, and all gates.

PART 2 PRODUCTS

2.1 GENERAL

- A. General: Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power actuators. The Contractor shall furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.
- B. Materials: All actuators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.
- C. Mounting: All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48 and 60 inches above the floor or the permanent working platform.
- D. Standard: Unless otherwise indicated and where applicable, all actuators shall be in accordance with ANSI/AWWA C540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.

- E. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with power and instrumentation equipment indicated elsewhere in the Contract Documents.

2.2 MANUAL ACTUATORS

- A. General: Unless otherwise indicated, all valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.
- B. Buried Valves: Unless otherwise indicated, all buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the Engineer. Wrench-nuts shall comply with AWWA C500 - Metal - Seated Gate Valves for Water Supply Service, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished. All buried valves shall have an operator shaft extension from the valve or valve operator to 6 inches below finished grade.
- C. Chain Actuator: Manually-activated valves with the stem located more than 7 feet above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.
- D. Floor Boxes: Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.
- E. Manual Worm-Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by

simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General:

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece.
2. Nameplate: A motor nameplate shall be provided stating model number, maximum torque, horsepower rating, voltage, amperage, service factor, etc.
3. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4, 4X, 6, or IP 68 assembly as specified. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. All gearing shall be accurately cut with hobbing machines. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor without further disassembly of the electric actuator.
4. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
5. Switches and Wiring: Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by an encoder that directly senses torque in the actuators gear drive. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The actuator shall have a number of gear trains as required to produce the operation indicated. The actuator shall be wired in accordance with the schematic diagram. All wiring for external connections shall be connected to marked terminals. One 1-inch and one 1-1/4-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Position limit switches and associated gearing shall be an integral part of the valve actuator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of bronze or stainless steel, grease-lubricated, and enclosed in its own gearcase to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Limit-switches shall be rated 5 amps at 120 VAC.

6. Handwheel Operation: A permanently-attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel.
7. Motor: The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480-volts, 3-phase or 120-volt, 1-phase as specified, 60-Hz current, and have Class F insulation and a motor frame with all dimensions in accordance with the latest revised NEMA MG Standards. The motor shall be suitable for submersible operation as specified. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. All bearings shall be of the ball type and thrust bearings shall be provided where necessary. All bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. The motor shall be furnished with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire actuator is a hermetically-sealed, non-breathing design with a separately sealed terminal compartment that prevents moisture intrusion.
8. Control Station: Each electric operator shall be provided with a control station containing three momentary pushbuttons labeled Open, Stop, and Close, and three indicating ultra bright LED lights labeled Open /Closed and fault. A Local/Remote selector shall be provided on the control station. The control station shall provide local control and indication and shall receive Open, Stop, and Close commands from a remote location. Control stations may be required to be provided as wall mounted separate from the operator if operator control station is inaccessible by operations staff due to height, location, or orientation. Otherwise, they shall be integrally mounted on the motor operator. Control stations shall be NEMA 4, 4X, or 6 where specified. Where indicated, control stations shall be in IEC IP68 enclosures, suitable for continuous submergence at a head of 20 feet of water.

B. Electric Motor Actuators (AC Reversing Control Type):

1. General: Where indicated, electric motor actuators shall be the AC reversing type.
2. Actuator Appurtenances: The actuator for each valve shall be supplied with open/close and fault ultra bright LED status lights; open, close and stop push

buttons and lockable Local Off Remote selector switch and all other devices indicated.

3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 120-volt, 1-phase, 60-Hz current. A control power transformer shall be included to provide a 120-volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120-volt ac, single-phase, 60-Hz space heater to prevent moisture condensation on electrical components.
4. Manufacturers, or Equal:
 - a. Rotork IQ
 - b. AUMA Actuators EQ, SQ, SA

C. Electric Motor Actuators (AC Modulating Control Type):

1. General: Where indicated, modulating electric motor actuators shall be the ac modulating type.
2. Control Module: The control module shall be of the electronic solid-state ac type with proportional pulse output to control the approach to setpoint speed of the motor.
3. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications up to 1200 starts per hour per IEC 34-1 to S4 50%. Power supply shall be 480-volt, 3-phase, 60-Hz.
4. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and push-button calibration elements for field-setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4-20 mA. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate 600 starts per hour at the 50 percent to 85 percent travel range of the valve.
5. Manufacturers, or Equal:
 - a. AUMA
 - b. Rotork

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General.

3.2 INSTALLATION

- A. All valve and gate actuators and accessories shall be installed in accordance with Section 15200 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance, without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

3.3 TESTING

- A. All valve actuators shall be tested in accordance with Section 15200 - Valves, General.

3.4 SUPPLEMENTS

- A. Special Constraints: Clearances at existing facilities are very tight. Contractor shall field verify all dimensions and existing conflicts prior to ordering material.

END OF SECTION

SECTION 15203 – CHECK VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI/ASME B1.20.1	Pipe Threads, General Purpose
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings
ANSI/AWWA C508	Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B16	Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines
ASTM A48	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B148	Specification for Aluminum-Bronze Sand Castings

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.
- B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.
- C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that check valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable.
- D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. A manufacturer/supplier's representative shall be present at the job site for a minimum of one half man day, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single Valve Manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 SWING CHECK VALVES (3-INCH AND LARGER)

- A. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with ANSI/AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS, unless otherwise indicated, with full-opening passages, designed for a minimum water-working pressure of 150 psi, unless shown on Contract Drawings or valve schedule. They shall have a flanged cover piece to provide access to the disc.
- B. Materials of Construction
 - 1. Body: The valve body and cover shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 125, 250 or mechanical joint ends, as indicated.
 - 2. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings. The disc ring shall be of Buna-N.
 - 3. Seat: The valve seat shall be of bronze conforming ASTM B62 or B148 - Specification for Aluminum-Bronze Castings.
 - 4. Hinge Pin: The hinge pin shall be of bronze or stainless steel.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. Milliken

2. American Flow Control (American Cast Iron Pipe Company)
3. APCO (Valve and Primer Corporation)
4. Kennedy Valve
5. Mueller Company (Grinnell Corporation)

2.2 SWING CHECK VALVES (2-1/2-INCH AND SMALLER)

- A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2-inch and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. They shall have screwed ends, unless otherwise indicated, and screwed caps.
- B. Materials of Construction
 1. Body: The valve body and cap shall be of bronze conforming to ASTM B61 - Specification for Steam or Valve Bronze Castings, or ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings, and with threaded ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch).
 2. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B16 - Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.
 3. Hinge Pin: The hinge pins shall be of bronze or stainless steel.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 1. Crane Company
 2. Milwaukee Valve Company
 3. Stockham Valves and Fittings
 4. Wm. Powell Company

2.3 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE)

- A. General: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.
- B. Materials of Construction
 1. Body: The bodies of all valves in sizes 3-inch and larger shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges,

and Pipe Fittings, with 125-lb flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body, or screwed into the body.

2. Valves smaller than 3 inches shall have bronze bodies with screwed ends conforming to ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch), suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise shown indicated. The type of bronze shall be suitable for the intended service.
 3. Disc and Stem: The disc and stem of all valves in sizes 3-inch and larger shall be of bronze conforming to ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications or stainless steel. The stem shall have two-point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.
 4. Valves smaller than 3 inches shall have discs and retaining rings of Teflon, Nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.
 5. Stem Guide: The stem guide must be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall furnish each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the shop drawing submittal.
 6. Seat: All valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. All resilient seats shall be firmly attached to the seating ring by compression-molding or other acceptable method.
 7. Spring: All valves in sizes 3-inch and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inch shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
1. APCO (Valve and Primer Corp.)
 2. CPV (Combination Pump Valve Company)
 3. Miller Valve Co., Inc.

4. VAL-MATIC (Valve and Manufacturing Corporation)

2.4 DOUBLE-LEAF CHECK VALVES

- A. General: Double-leaf check valves for air and gas service and where indicated, shall be of the wafer-type designed to fit between ANSI B16.1 flanges for 125-lb rating. The check valve leaves shall be spring-loaded. Flow from one direction shall cause the valve to open, and upon valve shutoff, the spring shall shut the valve leaves before reverse flow starts and at a point of zero velocity, for non-slam closure. The spring-tension of each valve shall be designed for the individual operating condition.
- B. Materials of Construction
 - 1. Body: The valve body shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings with integrally-cast seat, rated for minimum 150-lb working pressure at up to 250 degrees F.
 - 2. Leaves: The leaves shall be of bronze, aluminum bronze, or ductile iron, revolving on stainless steel or monel hinge pins with retainers.
 - 3. Seat: The valves shall have resilient seats for bubble-tight shut-off, suitable for temperatures up to 250 degrees F without sticking. The seats shall be Buna-N, Viton, or other suitable material for the intended purpose. The seat rings shall be firmly attached a shoulder cast in the body or to the disc by compression-molding or similar acceptable method.
 - 4. Springs: The springs shall be of Type 316 stainless steel, or Inconel, as best suited for the service condition.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. APCO (Valve and Primer Corporation)
 - 2. Milliken
 - 3. VAL-MATIC (Valve and Manufacturing Corporation)

2.5 SLANTING DISC CHECK VALVES

- A. General: Slanting disc check valves for water service shall have a seating angle of approximately 55 degrees. Valves shall have replaceable seat rings and disc rings. The water passage cross-sectional area shall be equal to the full pipe area. Valves shall have sufficient clearance around the pivot pins to permit free seating of the disc without binding and shall be guaranteed not to stick in the closed position. All slanting disc check valves shall have position indicators and two flanged connections for attachment of dashpots or hydraulic snubbers. The valves shall be designed for a water working pressure of 150 psi, unless otherwise indicated.

B. Materials of Construction

1. Body: The valve body shall be of cast iron conforming to ASTM A48 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings or A126 - Specification for Gray Iron Castings, class B, with flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, Class 125, unless otherwise indicated.
2. Disc: The valve disc shall be designed with an "aerofoil" configuration of cast iron or ductile iron, with bronze seating face, except for valves 10 inches or smaller, which may have solid bronze or aluminum bronze discs. The disc shall be partially balanced with a short travel, to resist slamming.
3. Seat Ring: The seat ring shall be of centrifugally cast bronze, aluminum bronze, or stainless steel, with beveled edges, firmly clamped or screwed into the valve body.
4. Pins: The pivot pins and bushings shall be of stainless steel, bronze, or aluminum bronze, to allow free movement of the disc without binding.

C. Dashpot: A top mounted hydraulic dashpot shall be provided to control the opening and closing cycle of the valve to prevent surge and water hammer. The dashpot shall have two control flow rates:

1. 90 percent rapid rate and
2. 10 percent slow rate during shut down and start up. Each rate shall be infinitely and independently adjustable. The dashpot shall be a self contained oil system separate and independent from the water line media. The oil reservoir for the closing cycle shall be stainless steel and open to the atmosphere with an air breather cap to prevent oil spillage. The oil reservoir for the opening cycle shall be stainless steel and hermetically sealed to contain pressure (air over oil) and be equipped with a 3-inch diameter pressure gage and pneumatic fill valve. There shall be a provision for disconnecting the dashpot from the valve for servicing, without removal of the valve.

D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.

E. Manufacturers, or Equal:

1. APCO (Valve and Primer Corporation)
2. Crane Company (Without Dashpot, Only)
3. VAL-MATIC (Valve and Manufacturing Corporation)

2.6 "DUCKBILL" CHECK VALVES

- A. General: Duckbill shall be a rubber and flow operated check type with a slip-on end connection suitable for attachment to Ductile Iron Pipe. The Contractor shall coordinate with valve manufacturer.

B. Materials of Construction

1. Body: The valve shall be furnished with Type 316 stainless steel band clamps. The valve shall be one piece rubber construction with nylon reinforcement. The port area shall contour down to a duckbill that shall allow passage of flow in one direction while preventing reverse flow.
2. Sleeve: The flexible duckbill sleeve shall be neoprene suitable for raw wastewater.

C. Manufacturers, or Equal:

1. Red Valve Company, Inc., Series TF-2

2.7 IN-LINE "DUCKBILL" CHECK VALVES

- A. General: Duckbill shall be a rubber and flow operated check type contained within a cast iron valve body, suitable for attachment to Ductile Iron Pipe. The Contractor shall coordinate with valve manufacturer.

B. Materials of Construction

1. Body: The valve body shall be cast iron. The valve shall be one piece rubber construction with nylon reinforcement. The port area shall contour down to a duckbill that shall allow passage of flow in one direction while preventing reverse flow.
2. Sleeve: The flexible duckbill sleeve shall be neoprene suitable for raw wastewater.

C. Manufacturers, or Equal:

1. Red Valve Company, Inc., Series 39

2.8 RUBBER FLAPPER SWING CHECK VALVES

- A. General: Rubber flapper swing check valves for water, sewage, sludge, and abrasives shall have full pipe size flow areas, one moving part only, and body seats at 45 degrees, to permit horizontal and vertical up-flow. Valves shall be designed for a minimum water-working pressure of 150 psi, with a flanged cover plate holding down the rubber flapper. The valves shall be of the non-clog design.

B. Materials of Construction

1. Body: The valve body and cover shall be of cast iron conforming to ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800. There shall be a threaded tapping in the bottom of the body for insertion of a back-flow device, and provision for mounting of a signal switch.
2. Disc: The valve disc or flapper shall be of Buna-N or other best-suited elastomer one-piece construction, precision molded, with integral O-ring type sealing surface, steel and nylon or fabric reinforced, with non-slam closing action through a 35-degree disc

stroke, for bubble-tight shut off at high and low pressures. The flexible hinge portion of the disc shall be warranted for 25 years.

- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. APCO (Valve and Primer Corporation)
 - 2. Milliken
 - 3. VAL-MATIC (Valve and Manufacturing Corporation)

2.9 PLASTIC BALL CHECK VALVES

- A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inch, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.
- B. Materials of Construction
 - 1. The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections, or flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. All seals shall have Viton O-rings and valve design shall minimize possibility of the balls sticking or chattering.
- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. ASahi-AMERICA
 - 2. George Fischer, Inc.
 - 3. NIBCO Inc. (Chemtrol Division)

2.10 PLASTIC SWING OR Y-CHECK VALVES

- A. General: Plastic swing or Y-check valves for corrosive fluids, in sizes up to 8 inches or as available, may be used for horizontal or vertical up-flow conditions. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inch and smaller. For larger sizes and other materials and temperatures the pressure rating will be lower.
- B. Materials of Construction
 - 1. The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction, as best suited for each individual service condition. They shall have flanged ends conforming to ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150, and

flanged top access covers, and they shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton.

- C. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- D. Manufacturers, or Equal:
 - 1. ASAHI-AMERICA
 - 2. George Fischer, Inc.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General and applicable requirements.

3.2 INSTALLATION

- A. The Contractor shall install the valves in accordance with the manufacturer instructions and Contract Documents.
- B. All valves shall be installed in accordance with Section 15200 - Valves, General.

3.3 TESTING

- A. All valves shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

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SECTION 15214 – PRESSURE CONTROL VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM A48	Specification for Gray Iron Castings
ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Specification for Ductile Iron Castings
ASTM B62	Specification for Composition Bronze or Ounce Metal Castings
ANSI/ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
ANSI/ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings.
ANSI/ASME B16.5	Pipe Flanges and Flanged Fittings, Class 125, 150, 250, or 300

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish submittals in accordance with Section 15200 - Valves, General.
- B. Shop Drawings: Shop drawings shall be in accordance with Section 15200 - Valves, General.
- C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable. A hydrostatic factory and functional test certificate shall be submitted to the Engineer prior to delivery of the valve.
- D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. A manufacturer/supplier's representative shall be present at the job site for up to two man days, travel time excluded, for assistance during installation, equipment startup, and testing.
- B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the site for up to 1 work days to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single Valve Manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 PRESSURE RELIEF VALVES, SIZES 1 1/2 INCHES THROUGH 42 INCHES

- A. General: The pressure relief valve shall open when the inlet pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a hydraulically operated, adjustable, pilot controlled, diaphragm or piston type globe or angle valve as indicated.
- B. Materials of Construction
 - 1. Body: The valve body shall be of cast iron, ASTM A48 - Specification for Gray Iron Castings, or ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with 250 lb flanged ends to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or the body shall be of ductile iron to ASTM A536 - Specification for Ductile Iron Castings, with 300 lb flanged ends to ANSI/ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and be of the same material as the body.
 - 2. Flange: ANSI B16.5 Class 125, 150, 250, or 300, as indicated.
 - 3. Valve Trim: The valve stems, springs, body seat rings, and all bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom or center guides. All rubber parts shall be of Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
- C. Valve Controls: The valve shall be furnished with a complete, externally mounted control system, including adjustable speed control needle valves, strainer, and all

necessary copper or stainless steel connecting tubing and fittings. The controls shall be capable of achieving all the flow and speed adjustment indicated.

D. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200 – Valves, General:

1. One liner (for piston valves, only (Golden-Anderson or Ross)).
2. One diaphragm (for diaphragm valves, only).

E. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.

F. Manufacturers, or Equal:

1. Bermad Control Valves
2. Cla-Val Company
3. Singer Valve, Inc.
4. Golden-Anderson
5. OCV Control Valves
6. Ross Valve Mfg. Co., Inc.
7. Watts, ACV

2.2 THREADED PRESSURE RELIEF VALVES, SIZES 1/2 THROUGH 2-1/2 INCHES

A. General: The pressure relief valve shall open when the inlet water pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a spring and hydraulically operated, direct-acting, adjustable, diaphragm or piston type globe or angle valve as indicated.

B. Performance Requirements: The valve shall be set for a relief pressure of 100 psi.

C. Materials of Construction

1. Body: The valve body shall be bronze with threaded inlet and outlet to standard NPT and with flanged top or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 – 150 lb or 300 lb flanged ends to ANSI/ASME B16.42 as specified, suitable for an inlet pressure of 300 psi. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting.
2. Valve Trim: The valve trim shall be of stainless steel or bronze with stainless steel spring. The rubber seat shall be replaceable.

- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
 - 1. Bermad Control Valves
 - 2. Cla-Val Company
 - 3. Singer
 - 4. Golden-Anderson
 - 5. Ross Valve Mfg. Co., Inc.

2.3 TEMPERATURE AND PRESSURE RELIEF VALVES

- A. General: Temperature and pressure relief valves for cold and hot water, steam, and air service, unless otherwise indicated, shall have a minimum pressure rating of 250 psi, bronze, steel, or stainless steel bodies, adjustable spring action, screwed or flanged connections, and trim to suit individual applications. Settings shall be adjusted for each specific condition.
- B. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- C. Manufacturers, or Equal:
 - 1. A.W. Cash Valve Mfg. Corp.
 - 2. Consolidated (Dresser Industries Valve Division)
 - 3. Fisher Controls Company
 - 4. Kunkle Valve Division
 - 5. Masoneilan (Dresser Industries Valve and Controls Division)
 - 6. Watts Regulator Company
 - 7. Wilkins Regulator (a Division of Zurn Industries)

2.4 THREADED PRESSURE REDUCING VALVES, SIZES 1/2 TO 2-1/2 INCHES

- A. General: Pressure reducing valves shall reduce a higher upstream pressure to a pre-set, lower, constant pressure, regardless of fluctuations in the upstream pressure. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the globe or angle pattern as indicated. All necessary repairs shall be possible without removing the valves from the pipeline. The smaller direct-

acting valves with threaded ends shall be suitable for water or air service and shall be of the globe patterns.

B. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42 as specified, with a minimum pressure rating of 300 psi, and with threaded ends. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.
2. Valve Trim: The valve stems, springs, body seats, and washers shall be of Series 300 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.

C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:

1. One liner (for piston valves, only (Golden-Anderson or Ross)).
2. One diaphragm (for diaphragm valves, only).

D. Protective coating. Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.

E. Manufacturers, or Equal:

1. Cla-Val Company.
2. Watts, ACV.
3. OCV Control Valves (Pilot operated only)
4. Bermad Control Valves

2.5 PRESSURE REDUCING VALVES, SIZES 2 TO 12 INCHES

- A. General: Pressure reducing valves shall reduce a higher upstream pressure to a pre-set, lower, constant pressure, regardless of fluctuations in the upstream pressure. When downstream pressure increases above a pre-set pressure the valve closes. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the wafer, flanged, or victaulic ends as indicated.

B. Materials of Construction

1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to

ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.

2. Flange: ANSI B16.5 Class 125, 150, 250, or 300, as indicated.
 3. Liner: Natural rubber, 65 durometer, Viton, EPDM, Nitrile, or Silicone as indicated. Liner retainer shall be 316 stainless steel.
 4. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.
- C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:
1. One liner (for piston valves, only (Golden-Anderson or Ross)).
 2. One diaphragm (for diaphragm valves, only).
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
1. Cla-Val Company.
 2. Watts, ACV.
 3. OCV Control Valves
 4. Bermad Control Valves

2.6 PRESSURE SUSTAINING VALVES, SIZES 2 TO 12 INCHES

- A. General: Pressure sustaining valves shall maintain a minimum pre-set upper system pressure regardless of fluctuations in the downstream system. The valves shall be hydraulically operated, with diaphragm or piston direct action, pilot-controlled, and shall be of the wafer, flanged, or victaulic ends as indicated.
- B. Materials of Construction
1. Body: The valve body shall be bronze to ASTM B62 or cast steel or cast iron to ASTM A48 - 125 lb or 250 lb flanged ends to ANSI/ASME B16.1 or ductile iron to ASTM A536 - 150 lb or 300 lb flanged ends to ANSI/ASME B16.42, with a minimum pressure rating of 300 psi. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm.

2. Flange: ANSI B16.5 Class 150 or 300, as indicated.
 3. Liner: Natural rubber, 65 durometer, Viton, EPDM, Nitrile, or Silicone as indicated. Liner retainer shall be 316 stainless steel.
 4. Valve Trim: The valve stems, springs, body seats, and washers shall be of 316 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.
- C. Spare Parts: The following spare parts shall be furnished in accordance with Section 15200:
1. One liner (for piston valves, only (Golden-Anderson or Ross)).
 2. One diaphragm (for diaphragm valves, only).
- D. Protective coating: Interior and exterior valve surfaces shall be coated in accordance with Section 15200 – Valves, General and Section 09960 – Protective Coatings.
- E. Manufacturers, or Equal:
1. Cla-Val Company
 2. Watts, ACV
 3. OCV Control Valves
 4. Bermad Control Valves

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General.

3.2 INSTALLATION

- A. All valves shall be installed in accordance with provisions of Section 15200 – Valves, General.

3.3 TESTING

- A. All pressure control valves shall be tested in accordance with Section 15200 - Valves, General.
- B. Factory Tests and Warranty: All valves shall be factory tested with a hydrostatic test and a functional test. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

END OF SECTION

SECTION 15230 – MISCELLANEOUS VALVES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall provide all miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 15200 - Valves, General, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AWWA C511 Standard for Reduced-Pressure Principle Backflow Prevention Assembly

1.3 CONTRACTOR SUBMITTALS

- A. The Contractor shall furnish submittals in accordance with Section 01300 – Submittals.
- B. Shop Drawings: Shop drawings shall contain, at a minimum, the following information:
 - 1. Valve name, size, pressure rating, and identification number (if applicable).
 - 2. Complete information on valve actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.
 - 3. Assembly drawings showing part nomenclature, materials, dimensions, weights, position indicators, limit switches, integral control systems, needle valves, and control systems.
 - 4. Complete wiring diagram and control system schematics.
- C. Certifications: Certifications shall be in accordance with Section 15200 - Valves, General. Affidavit of compliance that valves meet the requirements of the contract documents and the provisions of AWWA Standards where applicable.
- D. O & M manuals: O & M manuals shall be in accordance with Section 15200 - Valves, General.

1.4 QUALITY ASSURANCE

- A. Quality assurance shall be in accordance with Section 15200 - Valves, General.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. A manufacturer/supplier's representative shall be present at the job site for up to one half man day, travel time excluded, for assistance during installation, equipment startup, testing, and training.

1.6 MANUFACTURER'S UNIT RESPONSIBILITY

- A. Unless otherwise indicated, a single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve type; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve type.

PART 2 PRODUCTS

2.1 AIR VALVES

- A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.
- B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service and under pressure and be of the size indicated and shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.
- C. Combination Air Valves for Vertical Turbine Pumps: CAV's for vertical turbine pumps (installed on the pump discharge line, immediately downstream of the pump) shall vent large quantities of air through the discharge orifice when the pump starts, close tight when liquid enters and permit large quantities of air to re-enter through the orifice when the pump stops to prevent vacuum formation in the pump suction column. The valve shall be equipped with an air release valve to exhaust accumulated air in the system while under pressure. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated. The discharge orifice shall be fitted with a double-acting throttling device, to regulate and restrict air venting and to establish a pressure loading on the rising suction column of water to eliminate damaging shock to the pump, controls and check valve on pump start.
- D. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

E. Sewage Air Release Valves: Sewage air release valves shall vent accumulating gases during system operation. Valves shall have long float stems and bodies to minimize clogging. The same general requirements shall apply as indicated for air and vacuum valves. Each sewage air release valve shall be furnished with the following backwash accessories, fully assembled on the valve:

1. Inlet shut-off valve.
2. Blow-off valve.
3. Clear water inlet valve.
4. Rubber supply hose.
5. Quick disconnect couplings.

F. All air valves shall be coated in accordance with Section 09960 – Protective Coatings.

G. Manufacturers, or Equal:

1. APCO (Valve and Primer Corporation)
2. Crispin (Multiplex Manufacturing Company)
3. Golden-Anderson
4. Val-Matic (Valve and Manufacturing Corporation)

2.2 MUD VALVES

A. Mud valves shall be cast iron body, the stem, stem nut, disc ring, and seat ring shall be bronze. The bottom connection flange shall be coordinated with the connection pipe.

B. The extension stem shall be 316 SS, with cast iron stem guides as required. As indicated on the drawings floor stands shall be provided, otherwise a 2 inch AWWA nut and T-bar shall be provided.

2.3 BACKFLOW PREVENTER VALVES

A. General: Backflow preventers shall work on the reduced pressure principle. They shall consist of 2 spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.

B. Manufacturers, or Equal:

1. Cla-Val Company
2. Febco Div. (CMB Industries)

3. Hersey Products (Grinnell Corporation)
4. Watts, ACV
5. Wilkins Regulator Division (Zurn Industries)

2.4 SEWAGE SURGE RELIEF VALVES

- A. Performance Requirements: The valve shall open immediately when the system pressure exceeds the load setting, of the counterweights and shall close slowly at an adjustable speed upon return of system pressure to normal.
- B. Materials of Construction: Sewage surge relief valves shall be constructed of a heavy cast-iron or cast-steel body with a welded steel disc having rubber seating face, a non-corrosive shaft for attachment of counterweight or spring-loaded arms and lever, and a complete non-corrosive cushion chamber.
- C. Cushion Chamber: The cushion chamber shall be attached to the side of the valve body externally and be constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The cushioning shall be by oil stored in an oil reservoir attached by piping and fittings to the cushion chamber. The cushion chamber shall be so arranged that the closing speed will be adjustable to meet the service requirements.
- D. Manufacturers, or Equal:
 1. APCO (Valve and Primer Corporation)
 2. Golden-Anderson

2.5 CORPORATION STOPS

- A. Materials of Construction: Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required.
- B. Manufacturers, or Equal:
 1. Ford Meter Box Company, Inc.
 2. James Jones Company (Watts, ACV)
 3. Mueller Company (Grinnell Corporation)

2.6 SOLENOID VALVES

- A. General: Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure.
- B. Materials of Construction: Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient

seals with material best suited for the temperature and fluid handled. Solenoid valves in corrosive environment shall have stainless steel bodies. For chemicals and all corrosive fluids, solenoid valves with Teflon bodies and springs or other suitable materials shall be used. Enclosures shall be NEMA rated in accordance with the area designations of Section 16050 – General Requirements for Electrical Work. All coil ratings shall be for continuous duty. For electrical characteristics, see electrical drawings or Specifications.

C. Manufacturers, or Equal:

1. For General Duty:

- a. Automatic Switch Co. (ASCO), Model "RED HAT"
- b. Skinner Valve-Honeywell, Inc.
- c. Magnatrol Valve Corporation
- d. J. D. Gould Co.

2. For Corrosive Fluids:

- a. Valcor Engineering Corporation
- b. +GF+ Plastic Systems, Inc.

2.7 METAL NEEDLE VALVES

A. General: Metal Needle valves shall be rated for a minimum working pressure of 150 psi at a temperature of 125 deg. F, unless otherwise specified.

B. Materials of Construction: Needle Valves for water service shall be bronze body with one-piece stem and disc integral. The valve shall include a Teflon (PTFE) stem seal. The stem shall be 20 pitch fine thread (five turns from closed to fully open).

C. Manufacturers, or Equal:

1. Chemline
2. Asahi/America

2.8 PLASTIC NEEDLE VALVES

A. General: The valve shall be rated for a minimum working pressure of 150 psi at a temperature of 125 deg. F, unless otherwise indicated.

B. Materials of Construction: Plastic Needle Valves shall be globe-style with bodies made from PVC and threaded ends. The valve shall include a Teflon (PTFE) stem seal. The stem shall be 20 pitch fine thread (five turns from closed to fully open).

C. Manufacturers, or Equal:

1. Chemline
2. Asahi/America

2.9 THREE-WAY CONTROL VALVE

- A. The valve shall be an automated iron body valve with 316 stainless steel valve plug, stem and seat ring, electric actuator, remote temperature sensor and heater.
- B. CONTRACTOR shall provide a 24V, 60 Hz power supply which shall accept a 120 V, 60 Hz power feed for operation of the 3-way control valve actuator. The power supply shall be installed in a NEMA rated enclosure suitable for a Class 1, Div. 2 rated environment.
- C. Manufacturer, no equal, in order to match existing equipment:
 - 1. Honeywell, Model V5031 with Model M7284 motorized actuator.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. General: Delivery and storage shall be in accordance with Section 15200 – Valves, General and applicable requirements.

3.2 INSTALLATION

- A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, and wherever there is any danger of contamination, and where indicated.
- B. All valves shall be installed in accordance with the manufacturer's printed recommendations, and with provisions of Section 15200 – Valves, General.
- C. All backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

3.3 TESTING

- A. All valves shall be tested in accordance with Section 15200 - Valves, General.

END OF SECTION

SECTION 15250 – HYDRAULIC AND MANUAL GATES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install all tools, supplies, materials, equipment and labor necessary for the installation, testing, and placing into operation of all hydraulic gates with appurtenances, complete and operable, in accordance with the requirements of the Contract Documents.
- B. The provisions of this Section shall apply to all hydraulic gates specified, except where otherwise specified in the Contract Documents.
- C. The requirements of Section 15201 – Valve and Gate Actuators, apply to this Section.
- D. Gate materials shall be provided as listed in the Gate Schedule. No other materials will be considered.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes and regulations.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections in accordance with the requirements of Section 01300 - Submittals.
- B. Shop Drawings and Samples: In addition to the requirements of Section 01300 – Submittals, CONTRACTOR shall submit the following:
 - 1. Gate name, size, pressure rating, identification number (if any), and Specification Section number.
 - 2. Complete information on gate actuator, including sizing calculations, manufacturer, model number, limit switches, and mounting.
 - 3. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of gate handles, handwheels or cranks, position indicators, limit switches, integral control systems, and control systems.
 - 4. Complete wiring diagrams and control system schematics.
 - 5. Gate Labeling: A schedule of gates to be labeled, indicating in each case the location and the proposed wording for the label.
- C. O & M Manuals

1. Prior to start-up, the CONTRACTOR shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01730 - Operation and Maintenance Data.
 2. Manuals shall include printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units. Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the gates.
- D. Tools: Special tools necessary for maintenance and repair of the hydraulic gates shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.
- E. Quality Assurance: CONTRACTOR shall submit the following:
1. Manufacturer's Certificate of Proper Installation
 2. Functional Test Certification
 3. Factory performance test reports
 4. Special shipping, storage and protection, and handling instructions
 5. Manufacturer's printed installation instructions
 6. Spare parts list: The CONTRACTOR shall obtain from the manufacturer, a list of suggested spare parts of all items subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, etc., including all spare parts to maintain the equipment in service for a period of 5 years.
 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 8. Certification: The CONTRACTOR shall obtain written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the designated single manufacturer accepts the CONTRACTOR'S assignment of full responsibility for coordination of all equipment, including actuators and controls, and services required for proper installation and operation. The CONTRACTOR shall submit all such certificates to the ENGINEER.
 9. Guarantees, Warranties: After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that the hydraulic gates will meet these specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: All gate manufacturers shall have a successful record of not less than 5 years in the manufacture of the gates indicated.
- B. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products; such manufacturers shall have had previous experience in such manufacture and shall, upon request of the ENGINEER, furnish the names of not less than 5 successful installations of its equipment of comparable nature to that offered under this contract.
- C. Warranty: A written warranty shall be provided for the equipment specified in this section as required in Section – 01740 Warranty.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Manufacturer's Representative. In accordance with the requirements of Section 01660 – Testing and Adjusting, a Manufacturer's Representative shall be present at the site or classroom designated by the OWNER to provide the services and minimum person-days listed below, travel time excluded.
 - 1. 1 person-days for installation assistance and inspection,
 - 2. 1 person-days for functional and performance testing
 - 3. 1 person-days for pre-startup training of OWNER'S personnel.
- B. These services, and minimum person-days listed above, shall be provided for each gate type to be installed at the job site.
- C. No additional compensation shall be provided for the services of the manufacturer's service representative.

PART 2 PRODUCTS

2.1 GENERAL

- A. All combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the CONTRACTOR and the listed manufacturer shall be responsible for the compatible and successful operation of the various components of the units conforming to specified requirements. All necessary mountings and appurtenances shall be included.
- B. All gates shall have all of the features shown in the contract drawings, and in the supplemental gate schedule, attached to this Specification.
- C. Materials of construction
 - 1. General: All materials employed in the manufacture and installation of the hydraulic gates and actuators shall be suitable for the intended application; material not specifically called for shall be high-grade, standard commercial

quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

2. Nuts and Bolts: All nuts and bolts gates and supports shall be in accordance with Section 05500 – Miscellaneous Metals.
3. Gate Actuators: All gate actuators, regardless of type, shall be manufactured, installed, adjusted, and tested by the gate manufacturer at the manufacturer plant. All gates shall open counter-clockwise unless otherwise shown or specified.

D. Performance requirements

1. All gates shall be furnished complete with the accessories required to provide a functional system.
2. Refer to the Supplemental Gate Schedule, attached to this Specification, for specific gate requirements.
3. The leakage allowance for each type of gate shall be as specified in each gate section and as required in the applicable ANSI/AWWA Standard.

E. Actuators

1. Unless otherwise indicated, gate and valve actuators shall be in accordance with Section 15201 – Valve and Gate Actuators.
2. The electric actuators for all gates and valves shall be of the same actuator manufacturer. The CONTRACTOR shall be responsible to coordinate this among the gate and valve vendors.
3. Actuators:
 - a. Actuators shall be electric motor, handcrank, handwheel, or operating nut type as shown.
 - b. Weatherproof: Unless otherwise shown, actuators shall be weatherproof.
 - c. Pedestals: Actuators shall be pedestal mounted type unless otherwise shown. Pedestals shall be of cast-iron or fabricated steel. The pedestal shall have an ample base or wall-bracket area to evenly distribute the load to the supporting concrete structure. Unless otherwise shown, wall-brackets for the actuator and intermediate stem guides shall be provided
 - d. Stem and stem covers: The operating stem shall be the rising stem type with plastic covers unless otherwise shown. Rising stem gates shall be provided with clear polycarbonate stem covers ASTM D3935/D707. Vent holes shall be provided to prevent condensation. Stems shall be equipped with position indicators.
 - e. Manual lifts: Removable cast iron handwheels shall have a solid rim, be smooth and free of sharp edges and have an arrow to show the direction of the opening. Geared lifts shall have directional arrows and revolving brass grips. The maximum radius of the handwheel shall be 15 inches. All manual lifts shall be furnished with a bronze stop nut to

limit the downward travel of the stem and slide. Clockwise movement of the handwheel shall close the gate. Where indicated, the shaft shall terminate in a 2-inch square operating nut in lieu of the handwheel.

- f. Electric motor actuators: Gates shall be provided with electric actuators in accordance with Section 15201 - Valve and Gate Actuators, and the recommendations of the gate manufacturer.
 - g. The center line of actuator shall be approximately 3 feet above the base of the pedestal.
 - h. Sluice gate hoist heads shall be cast iron. The operating nut shall be of solid bronze conforming to ASTM B 584. Roller or ball bearings shall be included for thrust. Bearings and stem shall be provided with a lubrication system.
 - i. Crank: The unit shall be designed for a maximum of 40 lb on the crank to operate the gate. The operating crank shall be readily removable to facilitate the use of a portable power actuator. The direction of crank rotation to open the gate shall be indicated on the lifting mechanism.
- F. Frames: All sluice and slide gates shall be of the self-contained frame type, unless otherwise indicated on the contract drawings or on the supplemental gate schedule, attached to this Specification.
- G. Protective Coating: The exterior surfaces and the wet interior surfaces of all ferrous gates shall be coated in accordance with Section 09960 – Protective Coatings. The gate Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of gates shall not be epoxy coated. Where surfaces have been shop painted but have been damaged during delivery, storage or assembly, or where shop coats have deteriorated, these surfaces shall be properly cleaned and retouched or repainted with matching paint.
- H. Spare Parts: Where indicated, the CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the gate name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each gate. All spare parts are intended for use by the OWNER, only after expiration of the guarantee period.

2.2 SLUICE GATES

- A. General: Gates shall be new and of current manufacture. They shall be braced to prevent warping and bending under normal usage. Sluice gates shall be furnished with a crank-operated gear reduction floor stand as shown, and shall conform to ANSI/AWWA C501, except as otherwise specified herein.
- B. Performance requirements: Per ANSI/AWWA C560 the leakage allowance for sluice gates shall not exceed 0.1 gpm/ft of seating perimeter, and 0.2 gpm/ft of seating perimeter under 20 ft or less of unseating head. For unseating heads greater than 20 ft the allowable leakage shall not exceed the value calculated by the equations specified in ANSI/AWWA C560.
- C. Materials of construction

1. Frames and Slides: Gate frames and slides shall be of cast iron. All gate assemblies shall be shop tested and certified by the manufacturer to meet the maximum heads shown on the supplemental gate schedule, attached to this Specification. Slides and frames shall have well-machined seating faces, and the maximum clearance between seating surfaces, with the slide in the closed position shall be 0.004 inches. Sufficient adjustable wedging shall be provided to insure a practical watertightness, as specified in ANSI/AWWA C560. Seating faces shall be of Naval bronze, to ASTM B21 and fasteners, anchor bolts, studs, and adjusting screws shall be of Type 316 stainless steel conforming to ASTM A276, or as otherwise approved. Operating nuts shall be of bronze conforming to ASTM B584.
2. Stems: Stems shall be of Type 316, Type 304, or other approved stainless steel, conforming to ASTM A276 and shall be provided with adjustable bronze bushed stem guides to ensure that the L/R ratio of the stem does not exceed 200.
3. Wall Thimbles: Unless otherwise shown, all sluice gates shall be furnished and installed with cast iron, F-pattern, wall thimbles to match the thickness of the walls in which they are installed. For walls over 12-inches thick, the minimum thickness of the wall thimble shall be 12-inches or as recommended by the gate manufacturer based on the design parameters provided on the supplemental gate schedule, attached to this Specification. Where new gates are installed on existing wall thimbles, the CONTRACTOR shall field verify bolt pattern to ensure proper fitup of the new gates with existing wall thimbles. All existing bolts shall be replaced with new 316 stainless steel bolts when an existing wall thimble is used. These thimbles shall be supplied by the manufacturer of the gates, and they shall fit the bolt dimensions of the gates. All studs shall be of Type 316 stainless steel. For gates mounted on pipe, pipe flanges shall be used unless otherwise shown.
4. Sealant: The elastomeric sealant shall be Rubber Caulk Sealer (Optional: a Butyl Rubber Acetate mastic as recommended by the manufacturer of the gates) as manufactured by Product Research Company, Los Angeles, or equal.
5. Grout: Gates mounted against concrete walls without wall thimbles shall be installed with one inch of non-shrink grout between the wall and the gate flange. The anchor bolts and nuts shall be of Type 316 stainless steel.
6. Operating Mechanism: Operators shall be weatherproof, equipped with stem covers, and shall be mounted on cast-iron or fabricated steel pedestals. The pedestal shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure. The centerline of the manual operator shall be approximately 3 feet above the base of the pedestal. Sluice gate hoist heads shall be cast iron. The operating nut shall be solid bronze, ASTM B584. Operating thrust shall be taken on roller or ball bearings. All parts shall be provided with an alternate lubrication system. The unit shall be designed so that a no more than 40-lb of force on the crank is needed to operate the gate. Clockwise movement of the

handwheel shall close the gate. The operating crank shall be easily removable to facilitate the use of a portable power operator.

- D. Protective Coating: Sluice gates shall be coated in accordance with Section 09960 – Protective Coatings.
- E. Manufacturers, or equal:
 - 1. Rodney Hunt
 - 2. Hydro Gate Corp.
 - 3. Waterman Industries

2.3 SLIDE/ STOP GATES

A. GENERAL

- 1. All gates shall be new and of current manufacture, and adequately braced to prevent warpage and bending under the intended use. The gate slide shall be designed such that it will not deflect more than 1/1000 of the span of the gate at any point under the design head shown on the supplemental gate schedule, attached to this Specification. Where designated, gates shall be furnished with electric actuators.
- 2. All slide and stop gates shall be in accordance with the applicable ANSI/AWWA Standard.
- 3. Performance Requirements: The leakage allowance for all slide and stop gates shall not exceed 0.1 gpm/ft of seating perimeter under the design head, seating or unseating as specified, to meet ANSI/AWWA C561, C562, C563 and C513.
- 4. Mounting Hardware: Mounting hardware, if required, shall be of the size and type recommended by the gate manufacturer and shall be furnished as part of the guide frame.
- 5. Stop gates:
 - a. All stop gates of a given material shall meet all of the design and construction requirements as specified for slide gates of that material, except for the lifting mechanisms which are described below.
 - b. Handles: Dual handles are required for all gates wider than 3 feet. Mounting hardware, if required shall be type 316 stainless steel. Lift points shall be designed for the force required to lift the gate dead weight and overcome the friction force due to a full water load. An impact of at least 50 percent shall be included. Lift points shall be attached to the gate so that there is no localized buckling or overstress.
- 6. Slide/Sluice Gates
 - a. Frames: Frames shall have the following design characteristics:

- 1) Guide Length: Sufficient to retain at least 2/3 of gate slide when gate is in fully open position.
 - 2) Additional Supports: Support guides as required to prevent buckling due to actuator forces using a slenderness ratio of $l/r < 200$.
 - 3) Yoke to Support Bench Stand Actuator: Form by 2 angles welded to gate frame. Deflection shall be less than $l/360$.
 - 4) Yoke Arrangement: Capable of allowing removal of slide.
 - 5) Gate frames shall be fitted with fixed sealing faces that surround the clear opening. The fixed sealing and sliding faces shall be ultra high molecular weight polyethylene.
- b. Stems: Stems shall be of Type 316 or other approved stainless steel conforming to ASTM A276 and shall be provided with adjustable bronze bushed stem guides to ensure that the L/R ratio of the stem does not exceed 200. The stems shall have stub acme machined rolled or cut threads, double lead, finished or polished to 32 micro-inch finish or better.
 - c. Operating Nut: The operating nut shall be of solid bronze, ASTM B584. Operating thrust shall be taken on roller or ball bearings. All parts shall be provided with an alternate lubrication system. Operating nut threads shall match stem threads.
 - d. Seals: All fabricated slide and stop gates shall be provided with resilient neoprene seals along the sides and across the top of the opening where submerged. A flush button removable neoprene seal shall be provided on the invert of all fabricated slide gates. Seat seals attached to the slide gate will not be acceptable. Seals shall be mounted such that they do not protrude into the specified opening of the gate. All slide and stop gates will have ultra high molecular weight polymer seat seals having an intrinsic viscosity of greater than 14 by test. The seat seals shall be provided on both upstream and downstream faces of the slide and shall be mechanically locked in the gate guides. The UHMW seat seals will be shaped to provide two bearing surfaces and two sealing edges on each face of the slide. The slide will be a tight fit between the sealing edges to limit leakage]
 - e. Gates requiring top closure: Gates to be installed where water levels exceed the top of the slide shall be equipped with top closure. Top closure shall consist of neoprene double lip seals along the top and sides of the gate opening. These seals shall be mounted on an additional perimeter frame and shall not protrude into the waterway. Lip seal attachment shall be stainless steel fasteners and retaining strips. The perimeter frame shall not require boxing out the edges of the gate opening.

7. Fiberglass gates:

- a. All bolts, anchor bolts, washers, and supports required in connection with the plastic or fiberglass items shall be in accordance with Section 05500 – Miscellaneous Metals.
- b. All plastic and fiberglass items shall be manufactured with the "matched die-molded method," of material suitable for potable water, and shall be certified for such use on the shop drawings. Bolts,

anchor bolts, nuts, washers, and supports shall be provided for all plastic and fiberglass items in accordance with the requirements of the manufacturers of the plastic and fiberglass items. All bolts, anchor bolts, washers, and supports required in connection with the plastic or fiberglass items shall be of Type 316 stainless steel.

- c. The CONTRACTOR shall furnish details, calculations, and Drawings showing the method of fabrication and verifying that the plates will withstand any normal pressures or forces exerted without buckling or otherwise being damaged.

B. ALUMINUM SLIDE GATES

1. Aluminum gates in liquids with a pH lower than 5, or higher than 9, shall be anodized. The gates shall have stiffeners, extruded aluminum frames with bearing bars of ultra high molecular weight polymer, resilient P-seals, and fully lubricated stems and actuators.
2. Materials of Construction
 - a. Materials are as follows:
 - 1) Aluminum, ASTM B209, B221 or B308, Alloy 6061 T-6.
 - 2) Neoprene, ASTM D 2000, Grade 2 BC 510.
 - 3) Ultra-high molecular weight polyethylene, ASTM D 12
 - b. Disc: Disc shall be of aluminum plate reinforced with standard aluminum shapes or extrusions welded to the plate.
 - c. Frames: Frames shall be made from aluminum extrusions and shapes and shall be welded to form a rigid frame around the opening. The frame shall be reinforced to limit deflection of the slide or frame components. The frame will be attached to the wall with anchor bolts and shall be of sufficient strength to prevent warpage, twisting or bending during installation and usage.
3. Manufacturers, or Equal:
 - a. Fresno Valves & Castings
 - b. Rodney Hunt Company.
 - c. Hydro Gate Corp.
 - d. Washington Aluminum Company, Inc. (WACO).
 - e. Waterman Industries, Inc.

C. ALUMINUM STOP GATES

1. Materials of Construction: Hand-lift stop gates with handles shall be fabricated of 1/4-inch aluminum as shown and shall be reinforced as necessary to assure long life under the specified operating conditions. Mounting hardware, if required, shall be of Type 316 stainless steel.

2. Manufacturers, or Equal:
 - a. Fresno Valves & Castings
 - b. F. B. Leopold Co. (Division of Sybron Corp.).
 - c. Washington Aluminum Co., Inc.
 - d. Waterman Industries, Inc.

D. STAINLESS STEEL SLIDE GATES

1. Materials of construction: Gate frame, slide and stem shall be made of type 316 stainless steel. Fasteners and anchor bolts shall also be of Type 316 stainless steel.
2. The minimum diameter of the stem shall be one inch.
3. Manufacturers, or Equal:
 - a. Rodney Hunt Company.
 - b. Hydro Gate Corp.
 - c. Waterman Industries, Inc.

E. STAINLESS STEEL STOP GATES

1. Materials of construction: Stainless steel stop gates shall be hand-lift type gates having handles and shall be fabricated from Type 316 stainless steel 3/8 inch or 1/4 inch thick as indicated. Gate guide frame and mounting hardware shall also be of Type 316 stainless steel.
2. Manufacturers, or Equal:
 - a. Rodney Hunt Company.
 - b. Hydro Gate Corp.
 - c. Waterman Industries, Inc.

F. FIBER GLASS SLIDE GATES

1. Fiber glass slide gates shall be constructed of 1/4-inch thick (min) reinforced plastic laminate fiber glass adequately reinforced for the operating hydrostatic pressure. Reinforcing members shall consist of rigid sandwich core construction integrally-molded to provide a smooth vertical surface.
2. Stem: The gates shall be equipped with Type 316 or other approved stainless steel lift stems and bronze lift nuts, and stainless steel lift stem extensions and cast iron pedestal.
3. Guide Frames: The gates shall be furnished with concrete-wall-mounted type guide frames of proper size to allow lifting or lowering of the gates smoothly. The guide frames shall be fiber glass reinforced plastic with factory-bonded corners.

4. Slides: Gate slides shall be reinforced with stiffeners such that, at the design head, ending stress is limited to 1/5 the ultimate strength of the material and deflection is limited to 1/1000 of the gate width.
5. Manufacturers, or Equal:
 - a. F. B. Leopold Co. (Division of Sybron Corp.).
 - b. Plasti-Fab, Inc.

G. FIBER GLASS SLUICE GATES

1. Fiber glass sluice gates shall be constructed of 1/4-inch thick (min) reinforced plastic laminate fiber glass adequately reinforced for the operating hydrostatic pressure. Reinforcing members shall consist of rigid sandwich core construction integrally-molded to provide a smooth vertical surface.
2. Stem: The gates shall be equipped with Type 316 or other approved stainless steel lift stems and bronze lift nuts, and stainless steel lift stem extensions and cast iron pedestal.
3. Guide Frames: The gates shall be furnished with concrete-wall-mounted type guide frames of proper size to allow lifting or lowering of the gates smoothly. The guide frames shall be fiber glass reinforced plastic with factory-bonded corners.
4. Slides: Gate slides shall be reinforced with stiffeners such that, at the design head, ending stress is limited to 1/5 the ultimate strength of the material and deflection is limited to 1/1000 of the gate width.
5. Gates shall be fitted with an adjustable wedging assembly comprised of a 316 SS wedging bar and silicon bronze adjusting bolts with locking nuts. The adjusting bolts shall be non-galling for long-term easy adjustment. Gate wedging assembly shall be initially adjusted at the factory; however, they shall be easily adjusted to achieve the specified leakage rate.
6. Pedestals: For non-self-contained guide frames a pedestal shall be furnished for mounting the operator.
7. Manufacturers, or Equal:
 - a. F. B. Leopold Co. (Division of Sybron Corp.).
 - b. Plasti-Fab, Inc.

H.

I. FIBER GLASS STOP GATES

1. Materials of construction: Fiber glass stop gates shall be manufactured of blue-green fiber glass reinforced polyester resin laminate material containing ultra-violet radiation deterioration and weathering inhibitors. Each gate shall be molded individually to the exact size required with handhole or T-handle and reinforced with integrally molded stiffeners or sandwich core construction. Guide frames shall be of cast fiberglass

reinforced polyester resin material, containing weathering and ultra-violet radiation deterioration inhibitors. Guide frames shall have factory-bonded corners. Mounting hardware, if required, shall be of Type 316 stainless steel.

2. Manufacturers or Equal:

- a. Warminster Fiberglass.
- b. Plasti-Fab, Inc.
- c. F. B. Leopold Co., (Division of Sybron Corp.).

2.4 WEIR GATES

- A. General: Weir gates shall conform to all the requirements of slide gates, except that they are to open downwards.

2.5 FLAP GATES

- A. General: CONTRACTOR shall furnish and install flap gates at the locations shown, complete and operable, including frames, wall thimbles, bracing, mountings, gaskets or sealant, and coatings.
- B. Design: Flap gates and frames shall be of cast iron construction. Flap gates shall have a rubber seating face mounted in a dovetail slot and held securely without the use of screws or fasteners. Gate frames shall have flat backs for attachment to wall thimbles or mounting flanges, unless otherwise shown.
- C. Wall Thimbles or Mounting Flanges: Unless otherwise shown, flap gates shall be mounted against wall thimbles with Type 316 stainless steel bolts and sealant or gaskets, or against mounting flanges with Type 316 stainless steel anchor bolts. The thimbles or mounting flanges shall be of the cast iron F-pattern type, to match the thickness of the walls in which they are installed, and they shall be supplied by the manufacturer of the gates, to match the bolt dimensions of the gates.
- D. Sealant: The elastomeric sealant shall be Rubber Caulk Sealer as manufactured by Products Research Company, Los Angeles; or approved equal.
- E. Grout: Gates mounted against concrete walls without wall thimbles shall be installed with one-inch of non-shrink grout between the wall and the gate flange. The anchor bolts and nuts shall be Type 316 stainless steel.
- F. Manufacturers of Equal:
1. Hydro Gate Corp., Model 50C for round openings;
 2. Rodney Hunt Company, Series FV-SPR.

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the manufacturer's instructions
- B. The CONTRACTOR shall prepare and load all material and articles for shipment in a manner that protects the equipment and coatings from damage in transit, shall include a packing list, and shall be responsible for and make good on any and all damage.
- C. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY" or "SPARE PARTS ONLY." All packing materials shall be fire retardant. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.

3.2 INSTALLATION

- A. Hydraulic gates shall be installed in accordance with the manufacturer's printed recommendations and the requirements herein, the procedures submitted with the CONTRACTOR-approved shop drawings and as shown, unless otherwise acceptable to the ENGINEER.
- B. Actuators shall be located to avoid interference with handrails and structural members.
- C. Sluice and shear gates: Just prior to setting each gate, a 1/8-inch thick layer of mastic grade polysulfide elastomeric sealant shall be applied to the back of the gate frame. After setting the gate the nuts shall be run down on the anchor bolts just far enough to make them snug and to cause the rubber sealant to begin to ooze out, but not far enough to produce any significant stress to the frame. Any excess sealant at the edges shall be removed. The sealant shall be allowed to cure for at least 7 days, after which the anchor bolt nuts shall be tightened to their final positions. If gaskets are being used, they shall be installed over the studs in one piece, or dovetailed and cemented with a liquid-type gasket material.
- D. Slide gates shall be installed in accordance with the applicable AWWA standard.
- E. Alignment: Equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, or other defects. Equipment shall be secure in position and neat in appearance.
- F. Lubricants: The installation work shall include furnishing the necessary oil and grease for initial operation.
- G. All damage to surface coatings incurred during shipment and/ or installation shall be repaired to the satisfaction of the ENGINEER prior to installation.
- H. Cleanup: After completion of the installation and testing, the CONTRACTOR shall remove all debris from the site, clean all the equipment and controls, and hand over his work in perfect operating condition.

3.3 TESTING

A. General:

1. All gate testing shall be in accordance with applicable standards of AWWA, ANSI, and ASTM.
2. Provide testing in accordance with Section 01650 – Facility Start up.
3. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate with actuators, in the presence of the manufacturer's factory service representative. Any excessive leaks shall be corrected and the equipment retested until found satisfactory. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.

- B. Performance Testing: If leakage exceeds the indicated criteria, modifications and corrections shall be made under the supervision of manufacturer's representative at no additional cost to the OWNER.

3.4 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION", are part of this Specification.

1. Gate Schedule

END OF SECTION

Gate Schedule

GATE NO.	DESCRIPTION	GATE TYPE	MATERIAL	WIDTH X HEIGHT (IN)	MAX SEATING HEAD* (FT)	FRAME TYPE	MOUNTING TYPE	ACTUATOR/ HANDLE TYPE	DOWNWARD OPENING (IN)	UPWARD OPENING (IN)	REMARKS
SC-GAT1	SCREENINGS INFLUENT GATE	STOP	FIBERGLASS OR STAINLESS STEEL	24W X 84H	3.5	NON SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	HANDLE	NA	NA	
SC-GAT2	SCREENINGS CHANNEL GATE 1	STOP	FIBERGLASS OR STAINLESS STEEL	24W X 66H	2.75	NON SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	HANDLE	NA	NA	
SC-GAT3	SCREENINGS OVERFLOW GATE	DOWNWARD OPENING WEIR	FIBERGLASS OR STAINLESS STEEL	32W X 36H	1.5	SELF- CONTAINED	WALL MOUNT	MOTORIZED	36	NA	DOWNWARD OPENING
SC-GAT4	SCREENINGS CHANNEL GATE 2	STOP	FIBERGLASS OR STAINLESS STEEL	24W X 66H	2.75	NON SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	HANDLE	NA	NA	
SC-GAT5	SCREENINGS EFFLUENT GATE 1	STOP	FIBERGLASS OR STAINLESS STEEL	32W X 66H	2.75	NON SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	HANDLE	NA	NA	
SC-GAT6	SCREENINGS MANUAL OVERFLOW EFFLUENT GATE	DOWNWARD OPENING WEIR	FIBERGLASS OR STAINLESS STEEL	32W X 36H	1.5	SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	MOTORIZED	36	NA	DOWNWARD OPENING
SC-GAT7	SCREENINGS EFFLUENT GATE 2	STOP	FIBERGLASS OR STAINLESS STEEL	32W X 66H	2.75	NON SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	HANDLE	NA	NA	
HW-GAT1	HEADWORKS INFLUENT OVERFLOW GATE	STOP	FIBERGLASS OR STAINLESS STEEL	24W X 80H	3.3	NON SELF- CONTAINED	EMBEDDED WALL EMBEDDED FLOOR	HANDLE	NA	NA	
PC-GAT1	PRIMARY CLARIFIER #1 INFLUENT GATE	SLUICE	FIBERGLASS OR STAINLESS STEEL	24W X 24H	3.2	NON SELF- CONTAINED	SURFACE MOUNT	MANUAL	NA	24	TOP SEAL REQUIRED

GATE NO.	DESCRIPTION	GATE TYPE	MATERIAL	WIDTH X HEIGHT (IN)	MAX SEATING HEAD* (FT)	FRAME TYPE	MOUNTING TYPE	ACTUATOR/ HANDLE TYPE	DOWNWARD OPENING (IN)	UPWARD OPENING (IN)	REMARKS
PC-GAT2	PRIMARY CLARIFIER #2 INFLUENT GATE	SLUICE	FIBERGLASS OR STAINLESS STEEL	24W X 24H	3.2	NON SELF- CONTAINED	SURFACE MOUNT	MANUAL	NA	24	TOP SEAL REQUIRED
EQ-GAT1	EQ BASIN GATE NO. 1 INFLUENT GATE	SLUICE	FIBERGLASS OR STAINLESS STEEL	16W X 16H	2.5	NON SELF- CONTAINED	SURFACE MOUNT	MANUAL	NA	16	
EQ-GAT2	EQ BASIN GATE NO. 2 INFLUENT GATE	SLUICE	FIBERGLASS OR STAINLESS STEEL	16W X 16H	2.5	NON SELF- CONTAINED	SURFACE MOUNT	MANUAL	NA	16	
EQ-GAT3	EQ PRIMARY INFLUENT MODULATING WEIR GATE	DOWNWARD- OPENING WEIR	FIBERGLASS OR STAINLESS STEEL	36W X 27H	2.25	SELF- CONTAINED	SURFACE MOUNT EMBEDDED FLOOR	MOTORIZED	27	27	DOWNWARD OPENING
EQ-GAT4	EQ RETURN – GATE NO. 1	STOP	FIBERGLASS OR STAINLESS STEEL	14W x 60H	5	MANUAL	SURFACE MOUNT	LIFTING HANDLE	NA	NA	
EQ-GAT5	EQ RETURN – GATE NO. 2	STOP	FIBERGLASS OR STAINLESS STEEL	14W x 60H	5	MANUAL	SURFACE MOUNT	LIFTING HANDLE	NA	NA	
PC2-GAT1	PRIMARY CLARIFIER #2 EFFLUENT GATE	SLIDE	FIBERGLASS OR STAINLESS STEEL	28W X 28H	9	NON SELF- CONTAINED	SURFACE MOUNT	MANUAL	NA	28	WALL MOUNT GATE OPERATOR
FIL-GAT1	FILTER INFLUENT PIT GATE	SLIDE	FIBERGLASS OR STAINLESS STEEL	28W X 28H	6.5	SELF- CONTAINED	SURFACE MOUNT	MOTORIZED	NA	28	WALL MOUNT GATE OPERATOR

*Max unseating head shall be equal to the max seating head listed.

SECTION 15430 - PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall furnish and install plumbing and specialties as shown, complete and operable with electrical connections of hook-ups as specified herein and in accordance with the Contract Documents.

1.2 WORKMANSHIP AND MATERIALS

- A. All work shall in strict accordance with the Uniform State Plumbing Code, and codes of the State of California, and any other authorities having jurisdiction. The Contractor shall have required certifications and be thoroughly familiar with the local codes. The Contractor shall obtain and pay for all necessary permits.
- B. Care shall be taken at all times to protect floors, stairways, and walls during the makeup, erection of piping, and placing of equipment. The Contractor shall remove all stains and repair all damage before final acceptance of the work.
- C. If, during the construction of this project, the Engineer finds materials that have identifying marks removed or lack such marks completely, he may reject such items until the Contractor has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof shall be determined by the Engineer.

1.3 CONTRACTOR SUBMITTALS

- A. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 GENERAL

- A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.
- B. Floor drains or floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.
- C. Painting
 - 1. All ferrous metal, except finished, galvanized and machine surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09960 – Protective Coatings. Prime colors shall be compatible with finish coats to be applied in the field.

2. Self contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.
3. All field painting shall comply with Section 09960 – Protective Coatings.

2.2 PIPING AND FITTINGS

- A. All cast iron sanitary, storm, and vent pipe and fittings shall be manufactured in accordance with and shall meet the requirements of ASTM A74 - Cast Iron Soil Pipe and Fittings. Dimensions of cast iron soil pipe and fittings shall be as given in Table 2 of ASTM A74.
- B. Hub-Less cast iron soil pipe and fittings with Clamp-All Type pipe couplings, or equal, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities. Hub-Less cast iron soil pipe and fittings shall meet CISPI Standard 301. Pipe couplings shall have Hi-Torque capacity and meet FM Standard 1680.
- C. All copper pipe and fittings for potable and service water 3 inches and smaller shall be Type L medium wall hard temper copper pipe with soldered fittings.
- D. Vent piping passing through the roof shall be flashed. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in all directions. Flashing shall be fabricated from 4-pound lead sheet.

2.3 INSULATION

- A. All piping, valves, and fittings shall be provided with insulation as shown or required by the manufacturer and in accordance with the requirements indicated.

2.4 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

- A. General: The Contractor shall provide all necessary hangers and supports. No perforated strap hangers and no wire supports will be permitted. Pipe supports shall be as indicated in Section 15006 – Pipe Supports.
- B. Hangers supporting insulated piping shall be sized to fit the pipe plus the insulation. Insulation at support points shall be provided with metal shields to prevent damage to the insulation.
- C. Spacing:
 1. Pipe support spacing for steel and cast iron pipe is given in Section 15006 – Pipe Supports.
 2. Copper pipe support spacing shall be not more than 6 feet between supports.
- D. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.
- E. Pipe hangers used to support uninsulated copper piping shall be copper or copper plated.

- F. All vertical piping shall be supported at the base with fittings made for this purpose or supported from the nearest horizontal member or floor with a riser extension pipe clamp.
- G. Anchors that are installed into existing concrete shall be Grinnel Figure 117, Modern Figure 740, or equal expansion case inserts. Drill clean holes for insertion of case and patch concrete around hole as required.
- H. Continuous slotted concrete inserts, if used, shall be Crawford Figure 148, Fee & Mason Figure 9000, or equal. The Contractor shall provide secondary angle supports between main inserts to handle the loads which can be properly supported by such arrangement.
- I. Concrete inserts shall be as indicated in Section 15006 – Pipe Supports. All inserts shall be galvanized.

2.5 PIPE SLEEVES

- A. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor. Where pipes pass through walls, sleeves shall be flush with the wall surface.
- B. All sleeves shall be Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.
- C. All buried or submerged pipe sleeves shall be coated by the manufacturer with a fusion bonded epoxy in accordance with the requirements of Section 09960 – Protective Coatings.

2.6 VALVES

- A. All valves shall be as indicated and shall conform to the requirements of the applicable Section(s) of these Specification.
- B. The Contractor shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shutoff control on the water system. Shutoff valves shall be placed on all hot and cold water connections to equipment and fixtures. Lavatory and sink stops with wheel handle shall be brass with chrome plating. Extra long barrel stops shall be used where supply piping is concealed behind partitions.
- C. All valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.
- D. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual test levers. The Contractor shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or as approved by the Engineer.

2.7 ACCESS DOORS AND COVERS

- A. Access doors, where required in ceilings for access to valves, controls, and other equipment, shall be Karp Assoc., Maspeth, N.Y., Style DSC-210, Inryco-Milcor,

Milwaukee, WI, Style AT, or equal. Doors shall be of sufficient size to allow access but shall be not less than 12 inches by 12 inches. Ceilings with lay-in acoustical tile will not require access panels. Valves and equipment located above ceiling tile shall have a 3/4-inch diameter blue plastic button with a letter "V" set in tile.

- B. Floor access covers in unfinished concrete floors not exposed to chemicals shall be galvanized cast iron with a clear opening of not less than 8 inches by 8 inches, and shall be as manufactured by Alhambra Foundry Company, Model A-2015; Neenah Foundry Co., No. R-6687, or equal. In traffic or chemical areas, access covers shall be as manufactured by Alhambra Foundry Company, Model A-1240; Neenah Foundry Co., Model R-1977, or equal, with clear opening of not less than 10 inches in diameter.

2.8 ROOF DRAINS

- A. Roof drains shall have galvanized cast iron drain bodies, threaded outlet, removable locking mushroom aluminum or brass stone stainers, clamping collars with integral gravel guards, receiver, deck clamp and extension sleeves where required.
- B. Manufacturers, or Equal:
 - 1. Josam Mfg. Co., Series 21500.
 - 2. Jay R. Smith Mfg. Co., Fig. 1010.
 - 3. Zurn Industries, Inc., Series Z-100.

2.9 OVERFLOW ROOF DRAINS

- A. Roof drains shall have galvanized cast iron drain bodies, threaded outlet, removable locking mushroom aluminum or brass stone strainers, clamping collars with integral gravel guards, receiver, deck clamp and extension sleeves where required. Inlet to extend two inches above roof level.

2.10 PARAPET DRAINS

- A. Lacquered cast iron body with flashing clamp collar and nickel bronze grate.

2.11 DOWNSPOUT NOZZLES

- A. Product Description: Cast bronze body and wall flange round with offset bottom section.

2.12 FLOOR DRAINS IN CONCRETE FLOORS

- A. General: Floor drains in concrete floors shall be of cast iron, in the sizes indicated, with sediment buckets. Each floor drain located on an upper floor shall have a clamping collar, with 4-lb sheet lead flashing, 12 inches minimum all around.
- B. Manufacturers, or Equal:
 - 1. Josam Mfg. Co., Series 31120.
 - 2. Jay R. Smith Mfg. Co., Fig. 2350.

3. Zurn Industries, Inc., Series Z-520-Y.

2.13 CLEANOUTS

- A. General: All cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs. Where underground or concealed, cleanouts shall be brought to floor level or as indicated in the Drawings and to accessible locations with access covers and frames.
- B. Manufacturers, or Equal: The following cleanouts, or equal, shall be provided:

Description	Josam Series	J. R. Smith No.	Zurn No.
Exposed Locations	58500-20	4405	Z-1440-A
Underground (finished floors)	56010/30	4143	ZN-1400-2
Walls, Concealed	58790-20	4535	ZN-1445-1-A
Traffic Areas	56070	4240	Z-1420-27

- C. All clean outs shall have a minimum diameter of 3 inches.
- D. Stack cleanouts shall be installed at the base of each stack. Cleanouts shall be galvanized cast iron with ABS plastic cleanout plugs.

2.14 HOSE BIBBS

- A. General: All hose bibbs in exposed locations subject to freezing shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs as specified in Section 10400 – Identifying Device. Where indicated, hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.
- B. Manufacturers, or Equal:

Fixture Type	Description
Non-freeze post-type	Exposed bronze hydrant, post-type, depth of bury as indicated on drawings or to suit local conditions; minimum 4 feet. 1. Iowa Woodward, Model Y1. 2. Zurn, Model Z13857 or Z1340 3. Josam, Model 71700.
Hose valve	Heavy-duty bronze hydrant, with composition disc, handwheel, cap and chain. Sizes 1-1/2-inch and 2-1/2 inch: 1. Murdock 2. James Jones
Hose valve	Size 1-inch, without cap and chain: 1. Murdock 2. James Jones

2.15 WALL-MOUNTED HOSE RACKS

- A. The Contractor shall provide wall-mounted hose racks at locations indicated. Racks shall be all welded steel construction, of minimum 8-gage sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of 3/4-inch or 1-1/2-inch hose. Where racks are located in the open, they shall be supported from two 2- by 2- by 1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.16 HOSES AND NOZZLES

- A. The Contractor shall furnish a 75 foot length of hose in the size indicated on the Drawings for each hose rack shown on the Drawings
- B. Each length of hose shall be provided with male and female Cam & Grove fittings and nozzle. Hoses shall be non-collapsible seamless extruded rubber designed for a working pressure of at least 200 psi.
- C. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog. Nozzle material shall be polished brass. Nozzles shall have rubber bumpers.
- D. Nozzle Manufacturers, or Equal:
 - 1. W. D. Allen Mfg. Co., Illinois.
 - 2. Fire-End and Crocker Corp., New York.
 - 3. Halprin Supply Co., Illinois.
 - 4. Western Fire Equipment Co., California.

2.17 EMERGENCY EYEWASH/SHOWER

- A. Emergency eyewash/shower units shall be provided in and around the Chemical Storage and Feed Areas as indicated. The units shall provide protection against freezing and overheating of water supply pipes. All exposed water supply pipes for the unit shall be insulated with molded-type pipe covering, made of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. The insulation shall have a minimum thickness of 1 inch.
- B. Manufacturers or Equal
 - 1. Haws, Model No. 8300-FP
 - 2. Bradley Corp., Model S19-310NN.
- C. Eyewash drench showers shall meet the requirements of ANSI Z358.1-2004, Emergency Eye Wash and Shower Equipment.
- D. For eyewash/showers located within the chemical containment areas, the unit shall be corrosion resistant and manufactured of Schedule 80 PVC with an epoxy finish.

E. Manufactures or Equal:

1. Haws, Model No. 8336
2. Bradley Corp., Model S19-310PVC

2.18 FOAM CONTROL SPRAY NOZZLES

A. General:

1. Provide easy flush nozzles with discharges of 2.0 gpm at 10 psi gauge and spray angle of 120° to 130°. Spray nozzles shall be structurally suitable for pressure up to 200 psi.
2. Spray shall be flat, heavy sheet fan with uniform distribution. Fan width at the water surface shall not be less than 6.5 feet at 10 psi.
3. Spray nozzles shall be leaded bronze or brass. Provide neoprene rubber replaceable spray deflector.

B. Manufacturers, or equal:

1. Spraying Systems Co, Foam Control Nozzle, Series 22561
2. Lechler, Easy Flush Foam Control Nozzle, Series 564

2.19 SCUM MOVEMENT SPRAY NOZZLES

A. General:

1. Provide 15 degree spray angle flat spray type nozzles with discharges of 1.9 to 2.0 gpm at 10 psi gauge. Each spray nozzle shall be provided with an adjustable ball fitting. Ball fittings shall have a 3.8" male inlet and 3.8" female outlet. All materials shall be Type 303 SST.

B. Manufacturers, or equal

1. Spraying Systems Co., Veejet Style H-U
2. Lechler, Series 632

2.20 FULL CONE SPRAY NOZZLES

A. General:

1. Provide full cone flat spray type nozzles with discharge of 2.15 to 2.2 gpm at 10 psi gauge. Each spray nozzle shall be provided with an adjustable ball fitting. Ball fittings shall have a 3.8" male inlet and 3.8" female outlet. All materials shall be Type 303 SST.

B. Manufacturers, or equal

1. Spraying Systems Co., Fulljet Style HH

2. Lechler, Series 460

2.21 LIFE RINGS AND LIFE RING ENCLOSURES

- A. Life rings shall be provided at the Flocculating Clarifiers as indicated on the Drawings. Life rings shall be 30" diameter Coast Guard approved ring provided with at least 90' of rope.
- B. Life rings shall be provided with fiberglass enclosures designed for outdoor storage, mounted on the deck as indicated on the Drawings and as directed by the manufacturer. Enclosures shall be non-locking "T-Handle" type in safety yellow color.
- C. Manufacturer of Equal
 - 1. Cheyenne Inc., Model LRH-C

2.22 HUB DRAINS

- A. Hub drains shall be of pipe of the size and material indicated on the Drawings. The hub drain shall consist of a standard flared bell-end protruding approximately 2 inches above the top of the slab. Where no slab is called for a minimum 12-inch outside diameter, 6-inch thick concrete curb with two #4 reinforcing bar hoops shall be provided.
- B. Pipes discharging into the hub drain shall be securely positioned no more than 2 inches above the mouth of the hub drain opening in a location that will result in discharge of all drainage into the hub drain.

2.23 LIQUID CHLORINATION INDUCTOR

- A. The Contractor shall furnish a liquid chlorination inductor as indicated on the Drawings. The unit shall be corrosion resistant and manufactured to be compatible with 12% sodium hypochlorite solution.
- B. The liquid chlorination inductor system shall create a vacuum to pull chlorine solution into water main. The inductor system shall include a rotometer rate assembly for chlorine feed control, flow meter, and pressure gage. The inductor system shall be capable of 15 ppm dose with 12% sodium hypochlorite solution.
- C. The inlet connection shall be a female swivel adapter and the outlet connection shall be a male adapter matching the inlet supply size.
- D. The liquid chlorination inductor system shall include a 3/8" flexible suction tubing with an 8 ft length.
- E. Manufacturer of Equal
 - 1. Arden Industries, Model Bazooka

PART 3 EXECUTION

3.1 PREPARATION

- A. The Contractor shall coordinate roughing-in with provisions for wall-and floor sleeves, pipe inserts, cutting of roof and floor penetrations so that drain lines will have the required invert elevations and slopes.

3.2 OPENINGS

- A. New Construction: The Contractor shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. All openings shall be as indicated on the Contract Drawings or as required to provide passage for the plumbing work.
- B. Existing Construction:
 - 1. The Contractor shall provide all opening required in the existing construction walls, floors, and roofs for the passage of piping and plumbing equipment. All openings shall be as indicated or required for passage.
 - 2. All openings shall be cut in a neat and orderly manner, minimizing damage to existing structures. Patching of openings shall match existing construction.
 - 3. The Contractor shall be responsible for hangers and supporting members installed in existing masonry or structural steel as required for the proper completion of the Work.

3.3 INSTALLATION AND APPLICATION

- A. The Contractor shall provide all plumbing specialties in accordance with manufacturer's printed instructions.
- B. All pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.
- C. All pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.
- D. All piping in buildings shall be as close to the ceilings or walls as possible, unless indicated otherwise.
- E. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve or piece of equipment may be easily disconnected.
- F. All drainage and sanitary lines shall be properly run, trapped, and be vented to conform to Code requirements. All changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 3 feet.

- G. Horizontal soil, drain and waste pipes shall be given a slope of at least 1/4-inch per foot, unless indicated otherwise.
- H. Floor drains and cleanouts shall be installed so the tops of the drains are flush with the finished floor.

3.4 TESTING

- A. General: Contractor shall make such tests as are required by the local ordinances and codes in the presence of a local governing authority inspector to show that all piping is tight, leak free and satisfactory, and shall also perform such tests as the Engineer may direct to ensure that all fixtures and equipment operate properly. The Contractor shall pay all costs in making such tests and the costs of making all changes or repairs until the Work is acceptable to the governing authorities.
- B. Testing of piping shall conform to the requirements of Section 02640 – Pipeline Testing and Disinfection.

3.5 EQUIPMENT - DAMAGE AND REMOVAL

- A. The Contractor's operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment which are to remain in the finished work. Any damage caused by the Contractor or Subcontractor through their operations, shall be repaired by the Contractor to the satisfaction of the Engineer and at no additional cost to the Owner.

3.6 DISINFECTION

- A. After potable water supply lines are tested, they shall be disinfected by introducing into the line HTH solution, liquid chlorine, or chlorine solution of sufficient strength. Then the line shall be filled with water and maintained under not less than 10 pounds per square inch pressure, for not less than 48 hours, during which period all valves on the lines shall be opened and closed several times, after which it shall be flushed clean, and then tested by the Contractor. This procedure shall be repeated as often as necessary until the line is pronounced safe for use by the Owner. No cross connection between the water mains and any pipe not yet disinfected will be permitted.
- B. Disinfection of piping and fixtures shall conform to the requirements of Section 02640 – Pipeline Testing and Disinfection.

END OF SECTION

SECTION 15870 – FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. General: The CONTRACTOR shall furnish all labor, equipment, materials, tools, supplies, fittings, and appurtenances required for the design, fabrication, and installation of fiberglass reinforced plastic (FRP) ductwork including fittings, dampers, supports, and accessories as shown and as specified herein, in accordance with the requirements of the Contract Documents.
- B. The items specified under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.
- C. All FRP ductwork shall be manufactured of material suitable for the gases and chemicals specified, and shall be certified for such use on the shop drawings.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:
 - 1. ASTM C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service.
 - 2. ASTM D 638 Test Method for Tensile Properties of Plastics.
 - 3. ASTM D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 4. ASTM D 883 Definitions of Terms Relating to Plastics.
 - 5. ASTM D 2563 Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
 - 6. ASTM D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - 7. ASTM D 2584 Test Method for Ignition Loss of Cured Reinforced Resins.
 - 8. NBS PS 15-69 Voluntary Product Standard, "Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment."
 - 9. When two or more of the above regulations are applicable, the more stringent requirement shall be met.

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 Submittals.
 - 1. Drawings showing details of construction of the ductwork including the following:
 - a. All minimum laminate thicknesses.
 - b. All laminate ply sequences.
 - c. Location and size of all stiffeners.
 - d. Construction details for all joints, stiffeners, penetrations, support attachments, flanges, turning vanes, or any other assembly.
 - 2. Drawings showing all fittings, dampers, duct support locations, types, and details; wind and seismic brace locations, types, and details; and other appurtenances.
- C. O & M Manuals: The CONTRACTOR shall provide operators and maintenance data for all equipment furnished for the project in accordance with Section 01730, Operation and Maintenance Data.
- D. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.4 QUALITY ASSURANCE

- A. CONTRACTOR shall submit the following:
 - 1. MANUFACTURER's Certificate of Proper Installation
 - 2. Functional Test Certification
 - 3. Factory performance test reports
 - 4. Special shipping, storage and protection, and handling instructions
 - 5. MANUFACTURER's printed installation instructions
 - 6. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance.
 - 7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.
 - 8. The FRP ductwork supplier shall provide certification for the following:
 - a. The resin used has been tested in accordance with ASTM C581 and that the resin is compatible with an environment consisting of air, hydrogen

sulfide gas, methane, various aromatic hydrocarbon vapors, droplets of salt water, and droplets of water containing sodium hypochlorite, sodium hydroxide, and sulfuric acid.

- b. The fiberglass used has a flame spread rating of 25 or less and as measured in accordance with NFPA No. 255, Standard Method of Test for Surface Burning Characteristics of Building Materials.
- c. Samples: Samples of the manufacturer's standard gel coat colors shall be submitted to the ENGINEER for color selection.

B. Warranty

- 1. A written suppliers warranty shall be provided for the equipment specified in this section as required in Section, 01740 Warranty.

PART 2 PRODUCTS

2.1 DUCTWORK DESIGN

- A. General: All FRP exposed, concrete encased and buried air ducts, plenums and exhaust stacks shall be designed as specified herein.
- B. Wall Thickness: Minimum wall thickness shall be 1/4-inch. Additional thickness may be required to meet deflection, specific loading requirements or duct pressure operating requirements.
- C. Dimensions: The duct and plenum dimensions indicated on the drawings are net inside, indicating the clear space required inside the duct or plenum after lining is installed. Actual duct dimensions shall be increased to accommodate lining material, where lining is required.
 - 1. Design calculations for these conditions shall be furnished with the shop drawings.
- D. Deflection for exposed installation: The ductwork shall be designed to meet the following specification with respect to supports. Supports shall be designed and installed furnished by the Contractor at no extra cost. Maximum deflection of a side on a rectangular duct shall not exceed 2 percent of the width of the side at a test vacuum pressure of 6 inch W.C. Maximum deflection of round duct shall not exceed 2 percent of the duct diameter under an imposed hoop (point) loading of 550 lbs. After installation, horizontal rectangular ducting shall not sag in excess of 2 percent of the shortest side as measured from a straight and true centerline of the duct to the actual midpoint of the installed duct. Similarly, maximum sag of horizontally installed round duct shall not exceed 2 percent of the diameter. Duct supports shall be designed and installed such that the maximum deflections and sags specified are not exceeded. Any internal support components of the duct work shall not increase the system pressure drop.
- E. Duct Supports:
 - 1. Duct supports designed for static, dynamic, wind, and seismic loads. Supports and anchorage of all equipment shall be designed in Drawing S-1.
 - 2. Calculations for supports shall be signed by an engineer registered in the State of California.

3. CONTRACTOR shall note that the pipe support details in the DRAWINGS are not designed to resist seismic forces. CONTRACTOR shall design and install additional supports as needed to resist the seismic condition listed above. Design calculations shall be submitted to the ENGINEER in accordance with Section 01300, Submittals.

- F. Expansion and Contraction: Expansion joints shall be provided as needed. The minimum expansion and contraction provided for in the expansion joint specified elsewhere in this section shall be increased as needed due to calculated thermal movement. Expansion and contraction shall be determined on the basis of a temperature differential of 90°F. Thermal coefficients shall be determined by test for the laminate used, and the maximum expansion and contraction for the expansion joints.

2.2 MATERIALS OF CONSTRUCTION

- A. Resin: The duct shall be constructed using a high quality corrosion-resistant resin such as Hetron 992, Dow Derakane 411, or ICI America's Atlac 580. Selection of the proper resin for the chemical environment shall be based on the corrosion guides and previous experience of the resin manufacturer. The resin shall not contain any fillers except as required for viscosity control.
- B. Reinforcing Material: The reinforcing material shall be a commercial grade of glass fiber having a suitable bond between glass reinforcement and resin, such as manufactured by Owens-Corning, or Johns-Manville.

2.3 CONSTRUCTION

- A. General: Ducts shall be manufactured to the sizes and tolerances of National Bureau of Standards Voluntary Product Standard PS 15-69 except as modified in these specifications.

1. Physical Properties of Laminate: The laminate shall, in all cases, have the following physical properties:

2.	Physical Properties (at 73°F)	ASTM Test	Units	Value
3.	Minimum Ultim. Tensile Strength	D638	psi	12,500
4.	Minimum Flexural Strength	D790	psi	19,000
5.	Minimum Flexural Modulus of Elasticity (tangent)	D790	psi	800,000

- B. Laminate Construction: The laminate shall consist of a corrosion liner, a structural laminate, and an exterior layer.

1. Corrosion Liner: The inner surface of all laminates shall be a resin-rich C-glass veil and E-glass mat with a total thickness of 0.050 inch. The corrosion liner shall be applied in not less than two layers.
2. Structural Laminate: The corrosion liner shall be followed by a structural laminate of either hand-layup or filament wound construction. Minimum allowable structural laminate thickness shall be the minimum wall thickness specified in this section, less the corrosion liner thickness.

3. Exterior Layer: The exterior layer shall be resin-rich and reinforced with one layer of C-glass surfacing veil. The exterior layer shall be finished with a gel coat consisting of polyester resin, a pigment for color, and an ultra-violet light inhibitor. Minimum thickness of the exterior layer shall be 0.020 inch. The pigment and ultraviolet light inhibitor can be excluded in the encased and buried ducts.
- C. Flanges: Flanges shall conform to the specifications in PS 15-69.
1. Turning Vanes: Smooth bends or internal turning vanes shall be provided at elbows, tees, and other points in the duct system where air flow changes direction. Square-turn elbows shall be fitted with shop-fabricated double-blade turning vanes mounted inside rails. Construction shall be of the same material as the ductwork and rigid enough to prevent vibration at high air flow.
 2. Drainage: Ducting shall be specifically designed to facilitate water drainage; raised lips at duct joints will not be accepted.

2.4 WORKMANSHIP

- A. Visual Defects: ASTM D2563 shall be used for quality control of both filament-w o u n d and hand lay-up construction. Acceptance levels shall be as follows:

Process Surface:	Defects:
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Dry Spots	None
Entrapped Air	None at surface. If in laminate 1/16-in dia max and 5/sq max
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits	Max 1/8-in dia X 1/32-in deep, max 10/sq ft.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 10 percent of wall thickness.
Sharp Discontinuity	None

Non-Process Surface:	Defects:
Blisters	Max 1/4-in X dia 1/16-in high.
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall.
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq in/sq ft
Entrapped Air area.	1/8-in dia max; no more than 3 percent of area.
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate.
Pits	Max 1/8-in dia X 1/16-in deep.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in.
Sharp Discontinuity	None

- B. If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas may be repaired and reinspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.
- C. Shop Inspection: The ENGINEER shall be permitted access to the plant area at all times during fabrication and shall be notified one week prior to the estimated date of tests and/or inspections. Final inspection and approval shall be obtained prior to shipment unless written waiver is obtained. The shop inspection of the equipment shall include the following:
1. Check for compliance with drawing dimensions and adherence to construction standards.
 2. An acetone wipe test to check surface cure. No surface tackiness is permitted.
 3. A Barcol hardness test; at least 90 percent of manufacturer's specified hardness must be attained.

4. Examination of laminated (nozzle) cutouts.
5. A hydrotest of at least 24 hours duration to check for leaks.

2.5 DAMPERS

- A. Control dampers shall be the locking quadrant type and shall be constructed of a vinyl ester resin fiberglass. The thickness of the flange mount channel frame and blade shall be recommended by the manufacturer. Damper components shall be epoxied together and/or held in place with monel fasteners. Blade shall be stiffened as required. Frame shall be equipped with full circumference blade stop. Blade shall have a full circumference viton seal.
- B. A mechanism for positively locking the damper in position shall be provided. Each control damper shall be furnished with a hand lever or chain operator whenever it is more than six feet above the surrounding ground elevation.
- C. Chains shall be aluminum not less than 1/4-inch nominal size, and shall be looped to extend within 4 feet above the operating level. Twist chains or wire chains will not be accepted. Chain sprocket wheels shall be of the same material as the chain.
- D. Levers, chains, and chain sprocket wheels may be constructed of aluminum. It is the manufacturer's responsibility to furnish all associated parts of the damper of sufficient strength to support the chain.
- E. Dampers with chain operators shall be furnished with an indicator to show the open and closed position. The indicator shall be clearly visible from the operating level.
- F. All control dampers shall be able to operate in a partially closed position at a differential pressure of 4-inch w.c.
- G. All control dampers shall be furnished with seals to reduce leakage. Permissible leakages shall not be in excess of those in the published literature of the named manufacturers.
- H. Manufacturer: All dampers shall be as manufactured by Swartwout, Viron International or equal.

2.6 DUCT SUPPORTS

- A. Duct supports shall be designed to allow a maximum deflection of ½ " deflection at midspan. Maximum spacing between supports shall not exceed 20 feet. Duct supports shall be provided at all changes of direction.
- B. Point loads from supports are not acceptable. Protective sleeves that have 120° of contact and a minimum of 16" long or a minimum support width of 2" for 12" and 1 ¾" for 8" shall be utilized.
- C. All supports will be properly anchored to positively restrain the movement of the duct.
- D. All support materials utilized shall be FRP, PVC, or galvanized.

2.7 BIRDSCREENS AND INLET GRILLES

- A. All air intakes, except in the belt filter press hoods, shall be provided with FRP inlet grilles and bird screen of No. 8 mesh not less than 12 gage 316 stainless steel wire. Each bird screen shall be provided with a Type 316 stainless steel frame. Screens and grilles shall be securely held in place but shall be conveniently removable.

2.8 METAL ACCESSORIES

- A. All metal encased in or attached to any fiberglass item shall be Type 316 SS.

2.9 PROTECTIVE COATING

- A. Fiberglass ductwork shall not be painted. The color shall be impregnated in the exterior layer. Color shall be selected by the District.

2.10 MANUFACTURERS

- A. MANUFACTURER's Experience: The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufacturer who has been actively engaged in the supply of similarly sized FRP ducting for a minimum of 10 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the MANUFACTURER's recommendations and the Contract Documents.
- B. Manufacturers or Equal:
 - 1. Harrington Industrial Plastics, Inc.
 - 2. Ceilcote Company
 - 3. Beverly Pacific

PART 3 EXECUTION

3.1 DELIVERY AND STORAGE

- A. A complete set of MANUFACTURER's instructions covering storage, installation, operation, lubrication, and maintenance shall be furnished to the OWNER no later than the date the equipment is shipped. Care during storage and procedures for installation, lubrication, and startup of the equipment and motors shall be in strict conformance with the MANUFACTURER's instructions.

3.2 GENERAL

- A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations.
- B. No ductwork shall be fabricated or installed until it has been carefully coordinated with equipment specified elsewhere. Duct dimensions shown are "net" inside clear.

3.3 INSTALLATION

- A. Duct hangers and supports shall be fabricated out of materials as shown on the Drawings. Attachment of hangers or supports to fiberglass ducting with screws is unacceptable.
- B. All nuts, bolts and washers shall be type 316 stainless steel. Washers shall be used under all nuts and bolt heads.
- C. Gaskets shall be 1/4-inch thick full-face made of closed cell neoprene, sponge, silicone coated. Gaskets shall have a shore A hardness of not less than 50.
- D. Field joints shall be 100 percent sanded just prior to wet lay up (inside and outside). Field joints shall be made by wrapping with strips of reinforcement saturated with resins. The width of the first layer shall be 2 inches minimum and each layer shall increase in width uniformly until at least the thickness of the heaviest section being joined is achieved. Total minimum width of joint shall be 9 inches. Mating edges shall be coated with resin to cover all cut edges, and all voids shall be filled with a resin putty mix. The inside surface of joints shall be sealed with a wax resin mix where joints are not accessible. Where internal joints are accessible they shall be laid up with two 1-1/2 ounce mats then covered with a C-glass veil and sealed with a wax resin mix. All field joints shall meet or exceed duct section properties. Color match adjacent ducts shall be as close as possible.

3.4 EXPANSION JOINTS:

- A. Expansion joints shall be one piece bellows type made of 1/4-inch thick material with two-ply polypropylene reinforcement with a Hypalon exterior layer and butyl interior layer. The expansion joint shall be designed to span a 1 1/2-inch gap and to allow for widening of that gap to 3 inches, unless noted otherwise on the drawings or as needed by calculation.
- B. Flexible connectors shall be made with flanged materials with two-ply polypropylene reinforcement with a Hypalon exterior layer and butyl interior layer, or approved equal. A minimum clearance of 3 inches shall be maintained between the ends of duct or between the fan and end of duct. Flexible connectors shall be furnished at each side of all centrifugal fan connections to a duct.
- C. Expansion joints and flexible connectors between flangeless ducts and fan inlets shall be attached with two stainless steel bands.
- D. A watertight and airtight seal shall be provided at all joints.

END OF SECTION

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SECTION 15954 – HVAC SYSTEM BALANCING

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. This section includes HVAC system balance, as defined by AABC or NEBB, which constitute the process of testing, adjusting, and balancing each system component so that the entire system produces the results for which it was designed.
- B. Work shall include the proper use of instruments, evaluation of readings, adjusting the systems to design conditions, full implementation of all AABC/NEBB test report forms, and providing unbiased opinions of the deficiencies encountered and proposing corrective actions.
- C. Definitions:
 - 1. Certification of Personnel is the action of determining, verifying, or attesting in writing to the qualifications of an individual.
 - 2. Qualifications are the characteristics or abilities gained through training, experience, or both, that enables an individual to perform his work properly.
 - 3. Qualified Procedures are the test procedures developed and published by AABC, NEBB, AMCA, ASHRAE, or other nationally recognized Testing, Adjusting, and Balancing (TAB) Association or Agency.
 - 4. Supervision means that tests performed under this contract in any of TAB categories stated herein shall be under the direction and supervision of a TAB Level III employee on the Job Site.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AABC	National Standards for Total System Balance: Air Distribution, Hydronic systems, Air Pollution, Sound and Vibration
AMCA Publication No. 203	A Guide to the Measurement of Fan System Performance in the Field
ASHRAE	HVAC Applications Handbook
ADA Test Code No. 1062	Equipment Test Code
ANSI A1.4	Specification for Sound Level Meters
ANSI S1.11	Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets

1.3 CONTRACTOR SUBMITTALS

- A. General: CONTRACTOR shall submit administrative, shop drawings, samples, quality control, and contract closeout submittals of all equipment furnished this Section and in referenced Sections.
- B. Shop Drawings and Samples: Shop drawings and samples shall be submitted in accordance with the requirements of Section 01300 - Submittals.
- C. Testing Reports: CONTRACTOR shall perform equipment and systems tests, compile test data, and submit reports the ENGINEER. Specific procedures used in tests shall be performed in strict accordance with AABC or NEBB requirements and shall be included in the test report. CONTRACTOR shall identify equipment, drawing and identification code. CONTRACTOR shall submit data on printed report forms published by AABC or NEBB. All reports shall be certified by a TAB Level III Engineer. Each individual reporting form submitted must bear the signature and TAB Level of the data recording engineer.

PART 2 PRODUCTS – NOT USED**PART 3 EXECUTION****3.1 TESTING**

- A. Obtain air and water balancing and vibration and noise criteria testing performed by an independent air and water balance and testing agency currently certified by the AABC or NEBB. The testing agency shall be a specialist in the balancing and testing of mechanical systems.

3.2 PERSONNEL QUALIFICATIONS

- A. A TAB personnel qualification and certification program, meeting the following requirements, shall be maintained by the CONTRACTOR.
 - 1. The CONTRACTOR shall establish a written practice for the control and administration of TAB personnel training, examination, and certification.
 - 2. The CONTRACTOR's written practice shall include a written examination for each personnel TAB level.
- B. There shall be 3 levels of qualifying TAB personnel for each Tab category hereinafter listed:
 - 1. TAB Level I:
 - a. A TAB Level I individual shall be a high school graduate and shall have sufficient training and experience to perform the necessary tests in the TAB Category for which he is certified. A TAB Level I individual shall take test data and shall be responsible to a TAB Level II or TAB Level III Engineer in the applicable TAB Category.
 - 2. TAB Level II:

- a. A TAB Level II individual shall be (1) a graduate of a 4-year accredited engineering college or university, and shall have 2 years of experience in engineering, or equivalent in manufacturing, construction, and installation activities, or (2) be a high school graduate, having 4 years of experience in engineering activities or equivalent. In either case, 2 years of this experience shall be in TAB testing and procedures.
 - b. A TAB Level II individual shall direct and carry out tests in the category for which he is certified. He must also be able to set up and calibrate instruments, interpret test results, modify procedures as necessary, analyze data, and record the test results on appropriate forms.
- 3. TAB Level III:
 - a. A TAB Level III individual shall be (1) a graduate of a 4 year accredited engineering or science college or university, plus 5 years of experience in engineering, or equivalent manufacturing, construction, and installation activities, or (2) be a high school graduate, 10 years of experience in engineering, or equivalent manufacturing, construction, and installation activities. In either case, 2 years of this experience shall be in TAB testing and procedures.
 - b. A TAB Level III Engineer shall establish test procedures, designate test methods and procedures, and interpret test results. He shall be capable of evaluating the results, not only in terms of existing procedures, but also shall possess sufficient practical background in applicable HVAC technology to assist in establishing test procedures when none are otherwise available. He shall be responsible for conducting examinations of TAB Level I and TAB Level II personnel.
- C. TAB personnel shall be qualified and certified in the following generic TAB categories:
 - 1. Air Systems and Associated Equipment.
 - 2. Hydronic Systems and Associated Equipment.
 - 3. Sound.
 - 4. Vibration.
- D. Certification requirements of all levels of TAB test personnel shall be performed by the contractor. Certifications shall indicate the category and level of qualification in that category. Written statements verifying individual qualifications shall be available for review.

3.3 INSTRUMENTS

- A. Instruments used in testing mechanical systems and equipment shall be as recommended by the AABC, NEBB, AMCA, or ASHRAE. Test instruments used shall be initially and periodically checked thereafter to verify their calibration accuracy as described in AABC or NEBB procedures. Provide calibration verification of each test instrument with each test report.
- B. Test equipment shall be furnished by the CONTRACTOR and shall remain his property.

3.4 GENERAL PROCEDURES

- A. Systems and equipment as listed in the Specifications shall be tested and balanced in accordance with qualified procedures from the AABC or NEBB Standards.

- B. Procedures for each system test and equipment test shall be maintained on file by the contractor and shall be readily available to the Engineer if requested.
- C. Procedures used in tests shall be included in the submitted report.
- D. TAB contractor shall coordinate with the controls contractor for setting and/or positioning of control devices pertinent to facilitating testing and adjustment of all mechanical systems.

3.5 PRELIMINARY PROCEDURES

- A. Do all initial planning, including procurement of all available data, study of all systems, instrument selection and calibration, assembling all requisite report forms, study of construction documents and recording pertinent data on report forms, and performing all calculations possible.
- B. Inspect systems and equipment utilizing appropriate standards checklists to assure construction is complete and ready for balancing.
- C. Confirm that equipment installed matches data on report forms, including manufacturer, model, type, size, capacity, motor horsepower, rpm, etc.
- D. Maintain quality control during the execution of work through final completion.

3.6 AIR SYSTEM PROCEDURES

- A. Follow appropriate AABC or NEBB procedures for testing and balancing supply, return and exhaust air systems and systems with economizers and other energy conservation features where included as part of the Project. Balance flows to 5 percent of specified values.
- B. Specific systems shall include, but not necessarily be limited to: single duct constant or variable volume systems; pressure dependent, independent, or bypass variable volume systems; heating/ventilating systems; associated return air systems, general exhaust systems, and all special exhaust systems such as fume/particle removal, and smoke control/containment systems.
- C. Conduct tests for central air handling distribution systems at design air flow with simulated change out filter resistance.
- D. After each air system is balanced, indicate each damper set position with a fully visible, painted red or similar, permanent mark.
- E. Corrective measures, if required, shall conform to requirements of contract documents.

3.7 REPORT FORMS

- A. Report forms, as they relate to the specific Project, shall be fully implemented, including a sealed certification. Report forms shall include, but not be limited to: gas fired heating apparatus, fans, duct systems, air outlets, and instrument calibration.
- B. Report forms shall be standard forms as published by AABC or NEBB.

3.8 RETESTING

- A. During the period following completion of a specific test, and within the Project time frame, the ENGINEER may, at his discretion, request a recheck or resetting of any outlet, supply air fan, or exhaust fan as originally covered in the Scope of Work of this Specification. Retesting procedures, personnel qualifications, and report requirements shall be the same as the original requirements.

END OF SECTION

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SECTION 15955-EXHAUST FANS

PART1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work under this section includes labor, equipment, and material required for installation of exhaust fans as indicated on the Drawings and specified herein, including:
 - 1. Building Exhaust Fans
 - 2. Controls

1.2 SUBMITTALS

- A. Submittals shall conform to the requirements of Section 01330..
- B. Submit a complete list of materials, specialties and equipment for the installation. Literature shall be standard manufacturer's catalog cuts and items to be installed shall be clearly indicated.
- C. Each item shall be identified by manufacturer, brand and trade name, number, size, rating and whatever other data is necessary to properly identify and check the materials and equipment.
- D. Submit product data and dimensional drawings for each fan.
- E. Submit fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- F. Submit outlet velocity and the fan's inlet sound power readings for the eight octave bands, decibels and sones.
- G. Submit manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance.

1.3 OPERATION AND MAINTENANCE MANUAL

- A. The Contractor shall provide two Operations and Maintenance manuals for the fans and controls in accordance with the Special Provisions. Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Performance ratings: Conform to AMCA standard 211 and 311. Fans shall be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air performance seal
- B. Classification for Spark Resistant Construction, levels A, B and C, conform to AMCA 99.
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3)
- D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

1.5 WARRANTY

- A. Manufacturer's Warranty: Submit, manufacturer's standard warranty document executed by authorized company official.
 - 1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period shall be replaced by the manufacturer, including the fan, motor and all accessories provided by the fan manufacturer.

PART 2 PRODUCTS

2.1 GENERAL

- A. Equipment shall be identified by manufacturer's name or nameplate data.
- B. Equipment specified by manufacturer's number shall include required accessories and controls, listed in the catalog as standard with the equipment. Additional accessories shall be furnished as specified.
- C. Where no specific make of material or equipment is mentioned, a first class product of a reputable manufacturer may be used, provided it conforms to the requirements of the system and meets with the approval of the City.
- D. Equipment and materials damaged during transportation, installation and operation shall be replaced with new.

2.2 PERFORMANCE REQUIREMENTS

- A. Each fan shall meet the performance requirements in the table below.

Nominal Fan RPM	1725 rpm	
Max. Brake Horsepower	0.25	
Cubic Feet per Minute (CFM)*		
Static Pressure (inches WG)	CFM	SONES
0.00	1260	14.2
0.125	1209	13.8
0.25	1156	13.4
0.375	1100	12.9
0.50	1041	12.3

* Fan performance in the table above is based on Greenheck Model CW-99-D. Other manufacturers/models meeting these specifications with CFM performance values within plus or minus 5% of the values shown at the stated static pressure are acceptable. Noise requirements (Sones) shall not exceed those listed above at the stated static pressure.

2.3 DIRECT DRIVE SIDEWALL MOUNTED CENTRIFUGAL EXHAUST FANS

- A. General: Building exhaust fans shall be direct drive, sidewall-mounted centrifugal fans. The exhaust fan shall bear the AMCA Certified Ratings Seals.
- B. Wheel: Wheel shall be aluminum, non-overloading, backward inclined centrifugal. Wheel shall be dynamically balanced in accordance with AMCA Standard 204-205. Wheel cone and fan inlet shall be matched and have precise running tolerances for optimum performance and operating efficiency.
- C. Motors: Motors shall be in accordance with Section 16222 - Motors. Motor shall be totally enclosed fan cooled. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase. Motors shall be mounted on vibration isolators, out of the airstream. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants. Motors shall be accessible for maintenance. Motor shall be 480V 3-phase TEFC.
- D. Housing: Housing shall be constructed of heavy gauge aluminum; including the exterior housing, windband, and motor compartment housing. Galvanized steel is not acceptable. Housing shall have a rigid internal support structure. Windband shall be one piece uniquely spun

aluminum construction and maintain original material thickness throughout the housing. Windband shall include an integral rolled bead for strength. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it. Housing shall be leak resistant and continuously welded seam. Steel mounting plate and integral venturi shall be attached to windband.

- E. Motor Cover: Motor cover shall be constructed of aluminum.
- F. Vibration isolation shall be sized to match the weight of the fan.
- G. Drain Trough: Drain trough shall allow for one point drainage of water, grease and other residues.
- H. Accessories: Provide the following accessories:
 - 1. Birdscreen - Aluminum
 - 2. Wall grill - Aluminum louvered grill that mounts to the interior wall over the wall opening.
- I. Coating: Coating shall be baked enamel. Submit standard colors available for City selection.
- J. Acceptable Manufacturer:
 - 1. Greenheck Fans
 - 2. Approved equal

2.4 ELECTRICAL AND CONTROLS

- A. The Contractor shall be responsible for the proper coordination of control work and electrical work in connection therewith. Contractor shall also be responsible for the proper operation of the entire system. Electrical and controls work shall be performed in accordance with the applicable Division 13 and 16 Sections.
- B. The Contractor shall furnish and install line voltage control wiring, conduit, electric relays, switches, line voltage thermostats and other appurtenances as specified in applicable Division 13 and 16 Sections. A ground (green) conductor shall be provided in the power circuit and the motor circuit and shall be properly terminated.
- C. Calibration of Controls: The Contractor shall calibrate and adjust controls as required. Thermal overload shall be sized per full load current of the fan motor plus 15%
- D. Contractor shall be responsible for 120-volt controls conduit, wiring, and thermostat for stand-alone controls.

- E. Fan Motor Controller: Controller shall be located in the MCC as shown on the drawings.
- F. Control Description: When in auto mode, the fan(s) will be turned on and off based on the setpoints and signal from the thermostat controller. When in hand mode, the fan(s) shall be controlled using the start and stop push buttons. When in off mode, the fans shall not operate. The controls shall allow one or both fans to operate in auto mode at any given time.
- G. Refer to Electrical Drawings for control diagrams and additional requirements.

PART 3 EXECUTIONS

3.1 GENERAL

- A. Install fan equipment in locations indicated on the Drawings or indicated on the approved shop drawings. Follow the manufacturer's installation requirements. Contractor shall notify the District before installation into apparent improper locations of interference with other work such as electrical outlets, windows, cabinetwork or other features.

3.2 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation
- B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual
- C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

3.3 INSPECTION AND PREPARATION

- A. Verify that the fan system may be installed in complete accordance with pertinent codes and regulations and the approved shop drawings.

3.4 INSTALLATION OF EQUIPMENT AND STARTUP

- A. Equipment shall be installed in conformance with manufacturer's recommendations. Equipment shall be installed level and plumb. Fan and motors shall be anchored-bolted to the wall as required.

Fans shall be grounded as recommended by the manufacturer and required by NEC.

- B. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing all doors and passageways.
- C. Check each piece of equipment in the system for defects, verifying that all parts are properly furnished and installed, that items function properly and that adjustments have been made.
- D. Mechanical equipment shall be isolated from the building structure by means of noise and vibration isolators.
- E. Gaps between penetrating elements, ductwork, piping and the walls of the holes shall be filled on all sides with resilient material and sealed air tight on each wall with non-hardening sealant.
- F. Install equipment so that nameplates are easily visible.
- G. Where not otherwise indicated, equipment and material installation is published manufactures' recommendations. This requirement includes details, clearances and accessories.
- H. Startup shall be performed in accordance with the fan operations and maintenance manual.

END OF SECTION

SECTION 16000
REQUIREMENTS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section specifies electrical work including labor, electrical material, equipment, and installation and testing requirements for complete operating system. Electrical work shall also include demolition and or relocation and modifications of existing electrical equipment as shown and specified in these specifications. All equipment requiring power and or control shall include equipment furnished under this section and other sections of the specifications. The electrical drawings included in this project document are diagrammatic only and functional in nature and do not specify exact locations of equipment or equipment terminations. The scope of this project also includes all required work for a temporary 480V three-phase power to provide continued service to the existing wastewater plant during construction of the new facility. It is important to follow sequence of work specified in these specifications.

1.2 QUALITY ASSURANCE

- A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1	Minimum Design Loads for Building and Other Structures
IEEE 81	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
NEMA 250	Enclosures for Electrical Equipment (1000 Volt Maximum)
NEMA ICS 1	General Standards for Industrial Controls and Systems

Reference	Title
NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA ST20	Dry-Type Transformers for General Application
NEMA WD 1	General Requirements for Wiring Devices
NFPA 70	National Electrical Code (NEC)
CBC	California Building Code
UL 50	Enclosures for Electrical Equipment
UL 62	Flexible Cords and Cables
UL 67	Panelboards
UL 489	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 506	Specialty Transformers
UI 508A	Standard for Industrial Control Panel

- C. Identification of Listed Products: Electrical equipment and materials shall be listed by an independent testing laboratory for the purpose for which they are to be used. Three such organizations are Underwriters Laboratories, Inc. (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). The independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

1.3 SUBMITTALS

- A. The following specific submittal requirements for the switchgear, switchboard, motors, transformers, power distribution panels and starters or VFD's shall be followed:
1. Contractor shall formally place an order with equipment manufacturer within thirty days of the award of the contract. The order shall include all relevant drawings and specs including any addendum items associated with the equipment.
 2. Contractor shall submit shop drawings to the District as soon as possible or within 6 weeks of the order being placed for long lead items such as standby generator.
 3. Contractor shall forward review comments to equipment manufacturer within two days after receipt of the comments by the District.
 4. Contractor shall provide the release for manufacturing to equipment manufacturer within 3 business days of receiving a favorably reviewed submittal and shall provide the District with the shipping date.

5. Prior to shipment, a factory test of the equipment witnessed by the District shall occur.
- B. The following information shall be provided for all electrical equipment and materials in accordance with Section 01300:
1. Verification of fault withstand and interrupting ratings of all applicable power equipment and devices.
 2. Interconnection diagrams--The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified below.

Interconnection diagrams shall be drawn to reflect actual, physical relationship between equipment and or components as shown on the drawings. The interconnection diagram shall indicate wiring between panels, terminal boxes, remotely mounted devices, and motor starters. The diagrams shall interface with the manufacturer's internal connection diagrams for panels. The diagrams shall indicate the terminations to terminal blocks of field devices at each end of the cable, the number of conductors in the cable, the size of wire, and the number of spare conductors. For each termination, the diagrams shall indicate the terminal number, wire color, and wire number as it appears on the wire marker. All terminal blocks, including spares, shall be indicated on the diagrams. Interconnection diagrams shall be provided for review and approval prior to installation of equipment.
 3. Catalog-cuts including technical specifications, application information, ratings, and other information required to verify the equipment and/or material meets the requirements of this specification.
 4. A copy of this specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

1.4 PROJECT/SITE CONDITIONS

- A. General: Unless otherwise specified, equipment and material shall be sized and rated for an ambient temperature of 40 degrees C at an elevation ranging from sea level to 100 feet without exceeding the manufacturer's stated ratings.
- B. Seismic: All electrical equipment and supports shall be braced in accordance with latest California Building Code. Any and all equipment exceeding 250 lbs in weight shall be seismically constraint, and shall be provided with seismic calculations prepared by a California registered engineer.
- C. Classified Hazardous locations: The enclosed areas of the Headworks shall be Class 1 Division I hazardous location as defined by current NEC and NFPA 820. Similarly, area within 5 feet of existing Digester's exterior wall shall also be Class 1 Division 1 hazardous locations. Area within 5 feet beyond Class 1 Div a hazardous location shall be Class 1 Div 2 locations. All electrical and or devices located in such locations shall be classified

and suitable for use in such classified locations. All conduits entering or leaving the hazardous locations shall be provided with “O” seals per NEC.

All other outdoor locations and corrosive process areas shall be considered as NEMA 4X corrosive areas. All equipment located in these areas shall be rated as such with stainless steel or heavy duty injection molded fiberglass enclosures to resist corrosion.

1.5 ELECTRIC SERVICE

Electric service for this facility is existing and provided by Pacific Gas and Electric Company. Coordination with PG&E is required in this project for the relocation of the existing PG&E service transformer. Coordination with the District’s staff is also required.

Refer to Section 01140- Work Restrictions for general sequence of work and project constraints. General electrical sequence of work is part of the general sequence and is as shown on the drawings.

PART 2 PRODUCTS

2.1 GENERAL

Equipment and materials shall be new and free from defects. All equipment of the same or similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

Submit detailed conduit layouts for equipment located on the top deck of the Headworks and on the lower level of the Headworks for review and approval. Conduit layouts shall be on a full size drawings with conduit quantity and sizes.

2.2 RACEWAY, FITTINGS, AND SUPPORTS

- A. General: Conduit shall be provided for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems.
- B. Raceway:
 - 1. All exposed conduit in process areas and outdoor locations shall be threaded, PVC-coated galvanized, rigid steel conduit. All conduit accessories such as couplings, elbows, junction boxes etc. shall also be PVC-coated galvanized steel. Minimum size of conduit shall be 3/4 inch. Bushings shall be galvanized, malleable iron with insulating collars. Grounding bushings shall be locking type with a feed through compression lug. Unions shall be galvanized, ferrous alloy type. Threadless fittings are not acceptable. Running threads shall not be used in lieu of conduit nipples. Threaded hubs shall be used to terminate conduits entering boxes. PVC-coated RGS conduit shall be manufactured by Robroy Industries, Perma-Cote Industries, or equal. Conduits for indoors, non-process areas shall be rigid galvanized steel. Accessories such as junction boxes shall be compatible to the type of conduit used.

2. Liquidtight, flexible steel conduit shall be formed from spirally wound, galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight, plastic cover. Minimum size shall be 3/4 inch. Fittings for liquidtight conduit shall have cadmium-plated, malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.
3. Embedded or encased conduit shall be Schedule 40, high impact, polyvinyl chloride (PVC). Minimum size shall be 2 inch.
4. Fittings for PVC conduit shall be solvent welded type.

C. Boxes:

1. Boxes for use outdoors and in process areas shall be hot-dip, galvanized cast ferrous alloy type FD with integrally cast-threaded hubs for conduit entry. Boxes larger than FD boxes shall be welded steel and hot-dip galvanized after fabrication.
2. Boxes installed in areas where electrical metallic tubing is specified shall be standard UL approved electrogalvanized sheet steel, 4-inch square or octagon minimum trade size.
3. Conduit bodies shall be ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
4. Boxes for hazardous locations as indicated on the drawings shall be suitable for Class 1 Div I hazardous location. They shall be corrosive resistant, high tensile strength malleable iron and with threaded aluminum cover. They shall be manufactured by Crouse-Hinds, Appleton Electric, or equal.

D. Raceway Supports: Hot-dip galvanized framing channel shall be used to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps with galvanized iron clamp backs and nesting backs where required. Ceiling hangers shall be adjustable, galvanized carbon steel rod hangers. Straps or plumbers tape are not acceptable. Hanger rods shall be 1/2-inch all thread rod.

E. Concrete Pull Boxes: Provide and install pre-cast concrete pull boxes in locations indicated on the Drawings and as required by NEC. Pull boxes shall be:

1. Designed for heavy traffic conditions, with pull box and cover designed for heavy traffic bridge loading H-20
2. Minimum 2 feet by 3 feet by 3 feet depth with 3/4 inch diameter pulling irons located at each end. Concrete material shall be reinforced Class A.
3. Provided with engraved "Electrical" or "Instrumentation" or "Telephone" as applicable on the top side of the covers.

- F. Pull Boxes: Provide and install pre-cast concrete pull boxes in locations indicated on the Drawings and as required by NEC. Pull boxes shall be:

1. Designed for heavy traffic conditions, with pull box and cover designed for heavy traffic bridge loading H-20

2.3 CONDUCTORS, WIRE, AND CABLE

- A. General: Conductors, wires, and cable shall be provided for power, control, lighting, receptacles, instrumentation, grounding and signal circuits. The quantity and size of conductors shall be as specified.
- B. Power and Control Conductors: Power and control conductors shall be single conductor, stranded, annealed copper with 600-volt THWN/THHN polyvinyl chloride (PVC) insulation, Okonite, Okoseal-N; CABLEC; or equal.
- C. Lighting and Receptacle Circuit Conductors: Conductors for lighting and receptacle circuits shall be single conductor, annealed copper with 600-volt THWN/THHN PVC insulation. Conductor sizes No. 10 AWG and larger shall be stranded. No. 12 AWG shall be solid conductor. Minimum conductor size shall be No. 12 AWG. Conductors shall be Okonite, Okoseal-N; CABLEC; or equal.
- D. Grounding Conductors: Grounding conductors shall be as specified in paragraph 16000-2.7 A.
- E. Instrumentation and Signal Cable: Cable for instrumentation and signal circuit shall be twisted shielded pair or triad as specified, No. 16 AWG 7-strand copper with 600-volt PVC insulation, 100 percent aluminum-Mylar tape shield, No. 18 AWG tinned copper drain wire and overall PVC jacket, Okonite, Okoseal-N type P-OS, CABLEC, or equal.
- F. Splicing and Terminating Materials:
1. Connectors: Connectors for stranded conductors shall be tool applied tin-plated copper, compression type of the correct size and UL approved for the application.

Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals. Connectors for wire sizes No. 8 AWG and larger shall be one-hole lugs up to size No. 3/0 AWG and two-hole or four-hole for size 4/0 AWG and larger. Mechanical clamp, dimple, or screw-type connectors are not acceptable.

480-volt motor terminations shall be made using bolt connected lugged connectors and factory engineered kits consisting of heat shrinkable, polymeric insulating material with high dielectric strength mastic sealant.

Termination of solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating, tubular compression connectors.

2. Terminal Blocks: Terminal blocks shall be provided for external control and power wires size 10 AWG and smaller. Terminal blocks shall be 600 volts, heavy-duty, rated 20 amperes for control and 30 amperes for power.

3. Splices:

a. No splices are allowed without Engineer's written approval.

b. Wires #8AWG and larger shall be spliced with compression sleeve connectors with tool designed so that full compression must be applied before tool releases. Wires of different sizes shall be spliced with split bolt connectors. Splices shall be insulated with Scotch pre-shrunk tubing or layers of Scotch 33 + tape, half lapped built up to 1-1/2 times wire insulation thickness.

c. Wires #10AWG and smaller for power and control circuits shall be spliced with either compression sleeve connectors as in B.2 above or Scotchblock connectors (copper conductors or lighting fixtures connections only).

d. Splices in underground or wet locations shall be Scotchcast or otherwise sealed in approved waterproof epoxy casing.

G. Wire Markers: Wire markers shall be yellow or white shrink tubing, Thermofit Marker System (TMS) by Raychem Co., Thomas and Betts equivalent, or equal for conductors No. 10 AWG and smaller and locking tab cable markers, W.H. Brady Co., Thomas and Betts, or equal, for conductors No. 8 and larger. Letters and numbers identifying each conductor shall be machine printed in permanent black ink.

2.4 WIRING DEVICES

A. General: Receptacles, plugs, switches, and appurtenances shall be provided as specified on the drawings. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Receptacles and switches shall be premium, specification grade. GFI type in weather proof cover/box shall be provided for all outdoor receptacles.

B. Receptacles: Receptacles shall be 20A, 120V, grounding type. Receptacles for use outdoors and in wet process areas shall be corrosion resistant, GFI type, marine duty with polycarbonate weatherproof lift covers, Hubbell 53CM62/ 53CM21, General Electric, or equal.

C. Switches: Switches for use outdoors and in wet process areas shall be 20 amp, press-switch type with weatherproof, corrosion-resistant neoprene plate, Hubbell, Arrow-Hart, or equal. Switches located in classified hazardous locations shall be suitable for installation in such locations. They shall be made by Killard Hazloc Series, Appleton, Crouse-Hinds , or equal.

2.5 INDIVIDUAL MOTOR STARTERS

A. General: Unless otherwise specified, individual motor starters shall be combination type with molded case motor circuit protector, 3-pole, 600-volt AC contactor, and three

overload relays, NEMA size 1 minimum. Each motor starter shall be individually enclosed. Starters shall be manufactured by Cutler-Hammer, Allen-Bradley, General Electric, or equal.

- B. Enclosures: The door of the motor starter enclosure shall be interlocked with an externally operated disconnect handle, lockable in the open position. Enclosures shall be NEMA 12 for dry indoor areas and NEMA 4X for outdoor and wet process areas.
- C. Motor Branch Circuit Protection: Molded case motor circuit protectors shall be magnetic only with trip settings adjustable over a range of 700 to 1300 percent of the full load current of the motor served. The motor circuit protector, in conjunction with the starter, shall be rated to interrupt 42,000 amperes (symmetrical) unless otherwise specified.
- D. Overload Relay: Overload relays shall be bimetallic type with separate heaters for each of the three poles. Reset shall be accomplished with a reset pushbutton located on the unit door exterior. Trip setting shall be adjustable from 85 to 115 percent of the motor full load rating.
- E. Control Circuits: Control power transformers, fuses, and control devices shall be provided as specified. Two control transformer primary fuses, rated to interrupt 200,000 amperes at 600 volts, shall be provided on all motor starters. Each motor starter shall be provided with one control circuit secondary fuse rated to interrupt 10,000 amperes at 250 volts and sized at 125 percent of the control circuit full load current. Control circuit shall be 120 V with grounded leg.
- F. Wiring: Conductors shall be switchboard type and rated 90 degrees C above ambient temperature. Conductor shall be identified with tag numbers as specified.
- G. Manual Starters: Manual starters shall be provided as indicated on the drawings. Manual starters shall consist of a horsepower rated quick-make, quick-break toggle mechanism together with one or two overloads as specified. Voltage shall be as specified. Indoor and dry location shall be NEMA 12. For outdoor and wet process area, they shall be NEMA 4X corrosive resistant. For classified hazardous locations, they shall be rated for such locations and shall be manufactured by Square D, General Electric, or equal.

2.6 ELECTRICAL CONTROL DEVICES

- A. Control Devices:
 - 1. PUSHBUTTONS: Pushbuttons shall be flush head, heavy-duty, 600 volts, 10 amperes, continuous with NEMA rating to match enclosure types. Pushbutton operators shall be red for stop functions and black for all other functions. Escutcheon plates shall be as specified on the drawings. For field mounted pushbuttons, each stop pushbutton shall be provided with a galvanized steel padlockable mechanism. For hazardous locations, the control stations shall be rated as explosion proof suitable for such locations. They shall be Killark Hazloc Series, Appleton, Crouse-Hinds or equal.
 - 2. Selector Switches: Selector switches shall be heavy-duty, with NEMA rating to match enclosure type, rated 600-volt, 10-ampere, continuous. Switches shall be provided with contact blocks and number of positions as required to perform the

specified operations. The escutcheon legend shall be as specified on the drawings.

3. Indicating Lights: Indicating lights shall be heavy-duty, push-to-test, transformer type with 6.3-volt lamps. Indicating lights shall be NEMA rated to match enclosure type.
4. Control Stations: Unless otherwise specified, control stations shall be NEMA 12 or 13 for dry, indoor locations and NEMA 4X for process areas and outdoor locations, Allen Bradley Bulletin 800H, Crouse-Hinds NCS series, or equal. For classified hazardous locations, they shall be in NEMA 7 installed with proper "EYS" seals.
5. Security (limit switches). Security switches shall be heavy duty, industrial type with adjustable arm, lever made of stainless steel material. Each switch shall have one normally open and one normally closed contact rated for at least 5A at 120VAC. The switches shall be NEMA 4X, and shall be as manufactured by General Electric, Square D, or equal.

B. Control Relays:

1. Load-Switching Control Relays: Control relays used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.) shall be heavy-duty, machine tool type. Relays that have contacts used for remote interlocking or for which the switching load is not shown shall also be heavy-duty machine tool type.

Contacts shall, as a minimum, be 4-pole and be field interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.

AC relays shall have NEMA A600 contact ratings and electrical clearances for up to 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances of up to 250 volts.

Relays shall be Allen Bradley Bulletin-700, Square D Class 8501, or equal.

2. Logic Level Switching Control Relays: Control relays used for switching solid-state logic and signal circuits shall be Potter Brumfield series KUP, Schrack Series RA, or equal. Relays shall have a minimum of three SPDT, gold-flashed, fine silver contacts rated 3 amps resistive at 120 volts AC or 28 volts DC. Relay shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener. AC models shall have neon lamp indicator wired in parallel with coil.
3. Timing Relays: Solid state timing relays shall be pulse-count type using a high frequency RC oscillator and integrated circuit counter for timing. Electrolytic capacitors shall not be used in the timing circuits. Time delays from 0.1 seconds to 48 hours shall be available with each timer model adjustable over a 20:1 range. On-delay, off-delay, and single-shot timing models shall be available. Timer shall reset in 0.03 seconds or less. Timer accuracy shall be plus or minus 2.0 percent under normal conditions. The timing relay shall have two NEMA Form-C timed

contacts. Solid state timing relays shall be Agastat, STA series, Eagle Signals equivalent, or equal.

4. Intrinsically Safe Relays: These relays shall be suitable for use with 24VDC power source with pilot devices located in hazardous classified locations as defined by NEC Article 500. The relays shall be manufactured by :
 - a. R.K Electronics
 - b. Gem Sensors Division of IMO, Inc
 - c. R. Stalh, Inc.
 - d. Idec
 - e. Equal

Provide each relay with two DPDT contacts each rated for at least 5-amp.

All float switches located in Class 1 Div I hazardous location shall be provided with intrinsically safe relays located in control panel or where specifically shown on the drawings .

2.7 GROUNDING MATERIAL

- A. Cable: Grounding cable shall be concentric stranded, annealed bare copper. Cable size shall be as specified, and shall not be smaller than #4/0 AWG.
- B. Ground Rods: Ground rods shall be copper-covered steel, 3/4-inch diameter, and 10 feet long. Rods shall have threaded type, removable caps so that extension rods of the same diameter and length may be added where necessary. The rods shall be manufactured by ERICO, Galvan Industries, Inc. or equal.
- C. Compression Connectors: Compression connectors shall be cast copper as manufactured by Thomas and Betts, OZ. Gedney, or equal.
- D. Bolted Connectors: Bolted connectors shall be Burndy, O.Z. Gedney, or equal.
- E. Equipment Grounding: Install a green insulated equipment grounding conductor with each feeder and branch circuit from the power source grounding means to the load equipment or device.

2.8 LIGHTING FIXTURES:

- A. General: Unless otherwise specified, lighting materials, including fixtures, accessories and hardware, shall conform with the requirements specified in this section. Lighting fixtures shall be provided where specified.

Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified. Catalog numbers given on the applicable LIGHTSPECS shall not be used for selection of mounting hardware, but only as a reference to the type of fixture required. A concealed latch and hinge mechanism shall be provided to permit access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels. Fixtures recessed in concrete shall have protective coating of bituminous paint.

Fixtures shall be aligned and directed to illuminate an area as specified. Fixtures shall be directly and rigidly mounted on their supporting structures. Unless otherwise specified, conduit system shall not be used to support fixtures. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

B. Ballasts:

1. Fluorescent Magnetic: Ballasts for fluorescent lamps shall be nonleaking, thermosetting, compound filled, rated for 120-volt service unless otherwise specified. Ballasts shall be Class P, protected type, high power factor and shall carry the Certified Ballast Manufacturer's (CBM) and UL labels. Ballasts for fixtures located in covered, unheated areas and open areas shall be low temperature type. Electronic ballasts are also acceptable. They shall be low harmonic type and shall also have CBM and UL labels.
2. Mercury Vapor and Metal Halide: Ballasts for mercury vapor and metal halide lamps shall be autotransformer regulator high power factor type with a sound rating of "B" maximum. Starting current shall not exceed normal running current.
3. High Pressure Sodium: Ballasts for high pressure sodium lamps shall be autotransformer high power factor type. Starting current shall not exceed normal running current.

C. Lamps:

1. Acceptable Products: Lamps shall be General Electric, North American Philips (Norelco), Sylvania, Venture Lighting International, or equal.
2. General: Lamps shall be as specified on the applicable LIGHTSPECS.

Unless otherwise specified, fluorescent lamps shall be warm white, and mercury vapor lamps shall be phosphor-coated, deluxe white.

Unless otherwise specified, metal halide and high-pressure sodium lamp envelopes shall be clear.

Incandescent lamps shall be rated 130 volts AC. Unless otherwise specified, lamp shape shall be standard A or PS and envelope shall be frosted inside.

- D. Photoelectric Cell Units: Where shown and required on the drawings, photoelectric cell units shall consist of a cadmium sulfide cell housed in a plug receptacle assembly. The plug receptacle assembly shall be three-prong polarized locking type. Assembly shall be suitable for outdoor mounting and shall be rated for 1800 VA at 120 volts maximum capacity.

- E. Lighting Fixture Specifications Sheets (Lightspec): Lighting fixtures, including their related accessories, options, and hardware are specified in this section. Each LIGHTSPEC and lighting fixture type shown on the drawings is identified with a unique acronym of three or four digits, as follows:

1. Lamp Sources: The first digit of the fixture type indicates the basic or predominant lamp source from which the light is produced, as follows:

A	=	Atomic (self-energized)
F	=	Fluorescent
H	=	Mercury vapor (Hg)
I	=	Incandescent
HPS	=	High pressure sodium
M	=	Metal halide
N	=	Neon
X	=	Xenon

2. Family Groups: The second digit of the fixture type indicates a "family" of fixtures which share the same primary physical characteristics, such as appearance, construction or function. The family general requirements apply to all members of the family. The third digit of a four-digit fixture type, if used, distinguishes individual family members which have differing secondary features, options or multiple characteristics. All family members shall be produced by the same manufacturer and have matching characteristics. Family groups are as follows:

A	=	Area light
B	=	Bare lampholder or striplight
C	=	Corrosion-resistant
D	=	Downlight
E	=	Emergency
F	=	Floodlight
G	=	General, diffuse
H	=	Hazardous location
I	=	Industrial
L	=	Louver lens
M	=	Metal sided
N	=	Sign
O	=	Pool, or fountain, underwater
P	=	Patterned plastic lens
R	=	Roadway/parking lot
S	=	Steplight
T	=	Track-mounted
U	=	Under-cabinet
V	=	Vaportight
W	=	Wraparound lens
X	=	Exit sign

Lighting fixtures specified in the LIGHTSPECS are alphabetically arranged by lamp source and function.

3. Mounting Arrangement: The last digit of the fixture type distinguishes family members which have differing mounting arrangements, as follows:

B	=	Bollard
C	=	Cove

G	=	Ground
H	=	Handrail or pipe batten
L	=	poLe
M	=	seMi-recessed
P	=	Pendant
R	=	Recessed
S	=	Surface
V	=	Valance
W	=	Wall

- F. Example Catalog Numbers: The manufacturer's catalog numbers listed are examples of the basic model, or series, and the overall quality required. While the referenced catalog numbers attempt to be as definitive as available literature permits, such items as voltage, mounting style, modifications, and other special features may not be included. The Contractor, supplier, and manufacturer shall verify and provide all of the specified requirements.

2.9 DISTRIBUTION EQUIPMENT

- A. Panelboards: Panelboards shall be circuit breaker, dead front type with bus bar construction. Panelboards shall be composed of individually mounted circuit breakers designed to be removed without disturbing other breakers.

Bus shall be tin-plated copper and shall have a current rating as shown on the panel schedules sized in accordance with UL 67. Panel fault withstand rating shall be equal to the interrupting rating of the smallest circuit breaker in the panel.

Panelboards shall be provided with a separate ground bus and a full capacity neutral bus. Neutral bus shall be mounted on insulated standoffs with removable link connector to ground bus. Provide an inside pocket to hold circuit directory. Panelboards shall be Cutler-Hammer, Allen-Bradley, or equal.

For outdoor locations, provide lighting panels with NEMA 4X enclosures with padlockable provisions.

- B. Circuit Breakers: Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breakers rated 120/208 volts and 120/240 volts AC shall have a minimum interrupting current rating of 22K amperes (symmetrical) at 240 volts AC. Circuit breakers rated 277/480 volts AC shall have a minimum interrupting current rating of 65K amperes (symmetrical) at 480 volts.

Circuit breakers shall be bolt-on type.

Circuit breakers shall be listed in accordance with UL-489 for the service specified. Breakers rated 200A or higher shall be provided with solid-state trip unit with multi-functions which include long time and delay, short time and delay, ground fault.

Load terminals of circuit breakers shall be solderless connectors.

Circuit breakers and panelboards shall be products of the same manufacturer.

- C. Dry-type Transformers: Transformers shall conform to IEEE-C57.12.01 and UL 506. The voltage, frequency, number of phases, and KVA rating shall be as specified. Transformers shall have "Energy Star" label as required by latest California Energy Regulations Title 24. They shall be manufactured by Cutler-Hammer, Square D, General Electric, or equal.

Transformers 15 KVA and above shall have a Class 220 insulation system in accordance with NEMA ST20. Transformers 25 KVA and greater shall be designed not to exceed 80 degrees C temperature rise.

Transformer coils shall be copper windings. Aluminum windings shall not be acceptable. Transformer coils 15 KVA and above shall be impregnated with varnish. Transformer coils 10 KVA and below shall be encapsulated.

Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified. Provisions shall be made to permit separate grounding of the neutral conductor and the enclosure. Single-phase transformers shall be the four winding type.

Transformers 15 KVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.

Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.

Transformers rated 15 KVA and smaller shall be provided with weatherproof, non-ventilated enclosures.

Indoor transformers rated greater than 15 KVA shall be provided with drip-proof, ventilated enclosures. Outdoor transformers shall have weatherproof enclosures.

2.10 SURGE SUPPRESSION SYSTEM

Provide and install an UL 1449 listed surge suppression system of latest MOV type technology. The suppressor shall be of voltage type with thermal fusing. The suppressor shall be capable of withstanding 100,000 amperes per phase and shall be equipped with LED indicator, dry contact for remote alarm and local audible alarm. It shall be Square D SurgeLogic XW series, Cutler-Hammer, or General Electric, or equal system suitable for use with 480/277V three phase four wire service. All main service switchboard or MCC shall be provided with surge suppression system.

2.12 NAMEPLATES

Nameplates shall be made from laminated phenolic plastic. The nominal size of the nameplates shall be 3/4 inch high by 2 inches long. Nameplates shall have black backgrounds with 1/4-inch white letters. If abbreviations are required because of space limitations, abbreviations shall be submitted to the Construction Manager for approval prior to manufacture. Nameplates shall be fastened using self-tapping stainless steel screws. The use of adhesives will not be permitted on the outside of enclosures.

PART 3 EXECUTION

3.1 GENERAL

Unless otherwise detailed or dimensioned, electrical layout drawings are diagrammatic. Actual conduit installation shall be coordinated with field conditions. Junction boxes and pull boxes with quantity as required shall be furnished and installed. The Contractor shall coordinate the location of electrical material and equipment with the work.

Electrical equipment shall be protected from dust, water, and damage.

3.2 RACEWAY, FITTINGS, AND SUPPORTS

- A. General: The Contractor shall limit the number of directional changes of conduit to a total of not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet for each 90-degree change in direction.

Signal conduit shall be separated from AC power and control conduits. The minimum separation shall be 12 inches for rigid steel and 24 inches for PVC conduits.

Conduits installed in concrete floor slab shall follow requirements of the American Concrete Institute.

Tag power, signal and control conduits with stainless steel tag fastened to conduit with stainless steel cable. Tags shall be engraved with identification as designated on the single-line diagrams. Tags shall be installed at each conduit termination to an enclosure, MCC, control panel, disconnect, motor j-box, signal transmitter, sensor etc..

Cap each spare conduit as per detail shown on the drawings.

Apply anti-seize compound to all threads.

- B. Exposed Conduits: Rigid metallic conduit shall be assembled to provide a continuous ground path. Joints shall be made with standard couplings or threaded unions. Bends and offsets shall be made with a hicky or conduit bending machine or shall be factory preformed bends.

Exposed conduit shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel and perpendicular to walls, structural members, or intersections of vertical planes and ceiling. No conduit shall approach closer than 6 inches to any object operating above 30 degrees C.

Conduit supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors, die cast, rustproof alloy expansion shields, or cast-flush anchors. Wooden plugs, plastic inserts, or gunpowder driven inserts are not acceptable as a base for securing conduit supports.

Liquidtight, flexible steel conduit shall be used for the final connection to equipment, devices, and instruments where flexibility is required.

The length of liquidtight flexible steel conduit shall not exceed the lesser of 15 times the trade diameter of the conduit or 36 inches.

- C. Embedded or Encased Conduit: Conduits constructed in concrete which is in contact with earth shall be separated from earth by at least 3 inches of concrete. Clearances equal to the nominal conduit diameter but not less than 2 inches, shall be maintained between encased or embedded conduits except where conduits cross or terminate.
- D. PVC-coated Rigid Galvanized Steel Conduit: All exposed conduits shall be PVC-coated rigid galvanized steel with matching conduit boxes and accessories.
- E. "Eys" seals: Install "Eys" conduit sealing fittings as required per NEC, and as shown on the drawings for hazardous locations and locations as identified on the drawings. Fill the fittings with compound recommended by the fitting manufacturer.

3.3 CONDUCTORS, WIRE, AND CABLE

- A. General: Raceway construction shall be complete, cleaned, and protected from the weather prior to wire and cable being installed. Pulling wire and cable into conduit shall be completed without damaging or putting undue stress on the cable insulation. Soapstone, Talc, or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Nylon pull rope shall be pulled through the conduit immediately after concrete pour.

Each power, control, signal, and instrumentation conductor shall be identified at each terminal to which it is connected utilizing the wire markers specified in paragraph 16000-2.03 G.

600-volt conductors will be color coded as follows:

480 V Power

Phase A – Brown
Phase B – Orange
Phase C – Yellow
Neutral – White
Ground – Green

120/240 Lighting and Receptacles

Phase A – Black
Phase B – Red
Phase C – Blue
Neutral – White
Ground – Green

- B. 600-Volt Conductor and Cable: Slack shall be provided in junction and pull boxes. Slack shall be sufficient to allow cable or conductors to be routed along the walls of the box.

Conductors crossing hinges shall be bundled in groups not exceeding 12 and shall be so arranged that they will be protected from chaffing with spiral wrap when the hinged member is moved.

Raceway fill limitations shall be as defined by NEC and the following:

Lighting and receptacle circuits may be together in the same conduit in accordance with derating requirements of the NEC. However, lighting and receptacle circuits shall not be in conduit with other circuits.

Solid wire shall not be lugged nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.

For submersible pump cable installation, follow the pump manufacturer's recommendations and requirements. Furnish and install 316 stainless steel cable grips required to properly support the cables in addition to 316 stainless steel hooks and heavy duty, non corrosive, fiberglass cable ties as required. Cable grips shall be manufactured by Kellems, Hubbell, or equal.

- C. Signal and Instrumentation Cables: Signal and instrumentation circuits shall be run as individual shield twisted pairs or triads. Triads shall be used wherever three-wire circuits are required. Terminal blocks shall be provided at cable junction for running signal leads and shield drain wires. Each conductor shall be identified at such junctions. Instrumentation cables shall be continuous without any splices.

Shields shall not be used as a ground path.

3.4 WIRING DEVICES

Switches and receptacles for use outdoors and in process areas shall be mounted in "FD" type boxes or PVC-coated boxes in locations specified. Unless otherwise specified, switches shall be mounted 48 inches above the floor. Receptacles shall be mounted 18 inches above the floor in finished areas and 48 inches above the floor in process areas and outdoors unless otherwise specified.

3.5 INDIVIDUAL MOTOR STARTERS

Individual motor starters shall be mounted with the operating mechanism 48 inches above the finished floor unless otherwise specified. The Contractor shall size the overload heater elements to the nameplate full load amperes of the motor served. Motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.

3.6 MISCELLANEOUS CONTROL DEVICES

Control stations shall be mounted 48 inches above the floor unless otherwise specified.

3.7 GROUNDING

Electrical equipment and enclosures, metal surfaces of equipment, and metal structural members shall be grounded. Grounding system shall be provided in compliance with the NEC and as specified on the drawings.

Embedded and buried cable connections shall be made by cast copper compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire size 2/0 AWG and larger. Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires.

Grounding conductors which extend beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing.

Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit or terminated in a flush grounding plate.

Exposed ground connections shall be made by bolted connectors. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less.

Grounding conductors entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceway within terminating at the enclosure. Metal surfaces shall be cleaned prior to making grounding connections and bonds.

When install ground rods, field verify exact location of existing underground utilities such as water piping, gas piping, electrical conduits or ductbanks, vault or manholes etc prior to installation of the ground rods to avoid damage to the existing underground utilities.

3.8 LIGHTING FIXTURES

- A. General: The location and type of fixtures and receptacles are shown on the drawings. Raceways and wire shall be provided from the fixtures, switches, and receptacles to the lighting panel in accordance with the NEC.

Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to or greater than that of the fixture.

Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

3.9 PANELBOARDS

The contractor shall type in the circuit descriptions on the circuit directory as shown on the final record drawings or panel schedule.

3.10 TESTING

- A. General: Prior to energizing the electrical circuits, the tests shall be performed as specified. Unless otherwise specified, a 500-volt megohmmeter shall be used for resistance measurements.

The measurements of the tests shall be recorded on the specified forms and provided in accordance with paragraph 16000-1.3.

- B. Insulation Resistance Measurements:

- 1. General: General insulation resistance measurements shall be made on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA, or ANSI standards for the equipment or material being tested, unless

otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

2. Conductor and Cable Tests: The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Insulation resistance measurements shall be recorded and submitted to the Engineer for review and approval. Insulation with resistance of less than 10 megohms is not acceptable.
3. Motor Tests: All motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 100 megohms are not acceptable.

C. FUNCTIONAL CHECKOUT:

Prior to energization of equipment, the Contractor shall perform a functional checkout of the control circuit. Prior to functional testing, all protective devices shall be adjusted and made operative. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Contractor shall submit a description of his proposed functional test procedures prior to the performance of functional checkout.

The Contractor shall verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

D. GROUNDING SYSTEM TESTS:

The Contractor shall test each grounding connection to determine the ground resistance. The grounding test shall be IEEE Standard 81. A plot of ground resistance readings for each isolated ground rod or ground mat shall be provided to the Construction Manager on 8-1/2 x 11 inch size graph paper. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Ground rods required over that specified will be paid for as extra work. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.11 DEMOLITION

Contractor shall be responsible for demolition of the existing electrical equipment and shall removed unused electrical equipment and discard them in proper manner.

3.12 RECORD DRAWINGS

Record drawings refer to those documents clearly maintained and annotated by the Contractor during construction include record drawings in accordance with these specifications. Contractor shall submit record drawings that reflect as-installed conditions. Drawings do not conform or do not show as installed conditions shall be rejected and shall be resubmitted by the Contractor for no additional cost to the District until acceptance by the Engineer. Markups for deviations and changes shall be on a full size set of drawings.

3.13 SEQUENCE OF WORK

For general project construction sequence, refer to section 01040- Coordination for details. For electrical work, Contractor shall follow Sequence of Work as shown on drawing E-26. Submit plan for review and approval two weeks in advance. Follow all requirements including traffic controls and barricades to provide a safe area for the pedestrians. Coordination with other trades is also required.

3.14 TEMPORARY POWER DURING CONSTRUCTION

Temporary power 480V power from diesel generator is required in this project. The Contractor may utilize existing available 120V power at the plant to power his tool. However, the District shall not be liable for utilization of the power by the Contractor staff.

3.15 SWITCH-OVER STRATEGY

The existing plant shall remain functional while new Headworks is being built. Coordinate with the District regarding shut down of the existing system for the relocation of the existing PG&E service transformer , for the removal of the existing diesel fuel tank, and for new MCC's tie in. See sequence of work for detailed requirements.

3.16 TRAINING

In general, training shall be provided to plant staff as per respective specification sections. Training shall include both class room and hands-on sessions and shall not be less than 2-hour per session.

Approved O&M manuals shall be provided to attendees as well as additional training materials (hands out) neatly bound in 8½" x 11" binders for each attendee. Submit training schedule in advance for review and approval.

END OF SECTION

SECTION 16025
ELECTRICAL DEMOLITION AND MODIFICATIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, and incidentals required to demolish, modify and/or remove the electrical and instrumentation systems and equipment as shown on the Drawings or specified herein. All demolition work shall be performed by licensed electricians.
- B. Unless specifically noted as being reused, all conduit, wire, boxes, etc. detailed on the Drawings shall be new equipment installed under this Work.
- C. The electrical modifications and removals work shall consist of, but not necessarily be limited to, removal or modifications of existing equipment in the following generalized categories:
 - 1. Modification of motors, motor starters, panels, lights, outlets and other devices as indicated on the Drawings.
 - 2. Any electrically powered or controlled equipment indicated as being removed in this Contract and associated electrical appurtenances.
 - 3. Existing electrical equipment or electrical equipment associated with mechanical or process equipment which needs to be removed or relocated due to conflicts with new construction.
 - 4. Electrical control devices, starters, wiring, and other miscellaneous devices associated with equipment that will be modified or reused under this Contract.
 - 5. Instrumentation and control equipment and related conduit and wire associated with equipment being removed under this Contract.

1.2 RELATED WORK

- A. Additional requirements for equipment demolition and salvage are specified in Section 02050 – Demolition

1.3 SUBMITTALS

- A. All submittals shall be in accordance with Specifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EQUIPMENT TO BE REMOVED

- A. Only the major electrical and instrumentation equipment to be removed is shown or noted on the Drawings and failure to detail all equipment exactly shall not relieve the Contractor from the responsibility for its removal as directed by the Engineer. Removal items such as wire, conduit, junction boxes, anchorages, etc. are in general not detailed on the Drawings.
- B. Where removal of electrical, instrumentation, or any other equipment with wired connections is called for in this Work, the work shall include the removal of the associated electrical hardware as specified herein unless noted otherwise.
- C. Unless otherwise noted, all wiring shall be removed from the conduits; boxes and fittings and all exposed conduit shall be removed. Unless specifically noted otherwise, concealed conduits shall be cut flush with the floor, wall, or ceiling and plugged with non-shrink grout.
- D. Electrical power, control, or instrumentation equipment, exposed conduit, wiring, etc. rendered inoperative by modifications to existing equipment under these sections or other Divisions of this contract shall be removed unless specifically noted that it is to be abandoned in place.
- E. Not all existing conduits are shown on the Drawings. In general, existing conduits are shown only where they may be reused; or where they potentially affect or may be affected by new work under this Contract; or for providing useful background information to the Contractor regarding the existing electrical installation.
- F. Where existing conduit or wire associated with removed equipment is to be reused, it will be specifically noted on the Drawings or Conduit and Cable Schedules.
- G. No existing conduits, wiring, or electrical appurtenances shall be removed or in any way damaged unless allowed by the provisions of this Section. Any existing conduits or wiring or other electrical appurtenances that are encountered as an obstruction to new construction which are not covered by the provisions of this Specification shall be brought to the attention of the District.
- H. Where functions of existing cables or conduits are replaced by new cable or conduits because of additions of new panels, instruments, revision to control strategy, etc., the existing cables and exposed conduits shall be removed unless noted otherwise. Where shown on the drawings, or where terminating in equipment enclosures, concealed conduits shall be retained and marked as spares.
- I. Equipment removed shall not be reused under this contract unless specifically noted on the Drawings or Specifications.

- J. To minimize disruptions to the existing plant operations, the schedule for modifications and removal of existing equipment shall be coordinated with and approved by the Engineer and District.
- K. Where any existing circuits are disconnected due to abandonment or removal of existing equipment, the remaining motor starters or circuit breakers for these circuits shall be retagged as spares. At motor control centers, the tags shall be laminated nameplates matching the existing ones. In circuit breaker panels, the circuit card or listing shall be changed.
- L. Demolished and removed equipment, conduit, wire, etc., shall become the property of the Contractor unless specifically noted otherwise on the Drawings. Contractor shall be responsible for disposing removed equipment in conformance with the requirements of Section 02050 - Demolition. Where specifically shown on the Drawings, selected electrical equipment shall be protected, removed and turned over to the District per the requirements of Section 02050 - Demolition.
- M. Refer to mechanical sections for removal of existing diesel fuel tank and dispose of the hazardous substance in accordance with Federal and State Regulations.

END OF SECTION

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SECTION 16075 ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.2 SUMMARY

- A. Section Includes: Identification of electrical conductors, raceways and equipment, and electrical equipment signs.
- B. Related Sections:
 - 1. Section 16000 – Requirements for Electrical Work

1.3 REFERENCES

- A. National Electrical Code (NEC):
 - 1. Article 110–22 - Disconnecting Means.
 - 2. Article 210–4 - Multiwire Branch Circuits.
 - 3. Article 200 - Use and Identification of Grounded Conductors.
 - 4. Article 384 - Switchboards and Panelboards.
 - 5. Article 300 - Wiring Methods.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. General: Submit Shop Drawings for electrical equipment room layouts, drawn at a minimum at 3/8 inch = 1 foot, scale.
 - 2. Cross Reference: Diagram shall carry a uniform and coordinated set of wire numbers and terminal block numbers to permit cross-referencing between the Contract Document Drawings, the Drawings prepared by the CONTRACTOR, and equipment O&M Manual Drawings.
 - 3. Drawing number cross references and continuation references shall also be provided. Contractor-prepared Drawings shall reference applicable CONTRACTOR Drawings such as P&IDs, control and logic diagrams, interface wiring diagrams, Panel Drawings, etc. Contractor-prepared Drawings shall also reference applicable Drawings provided by equipment manufacturers.
 - 4. On any Drawing prepared for this project, if a wire, circuit, enclosure, panel, or device is continued on another Drawing, the continuation Drawing shall be referenced (and vice-versa). Wherever wires are shown connected to terminals, the Drawings which show the continuation of the circuits on those terminals must be referenced.
 - 5. Interconnection Diagrams: Cables shall not be installed into raceways until the wiring interconnection diagrams are reviewed by the design engineer.
 - 6. Sample schematics and diagrams are indicated on typical detail Drawings for reference and understanding of minimum information required for submittal of Shop Drawings schematics and diagrams, and submittal of O&M schematics and diagrams.
 - 7. Include tagging system, labels, markers, hazard tape, nameplates, and signs.

- B. Product Data: Include tagging system, labels, markers, and hazard tape.
- C. Project Record Documents:
 - 1. Document wire, cable, and conductor tags, and bundle tags installed in accordance with the Contract Documents.
 - 2. Document installed wire, cable, and conductor tags and bundle tags when not specifically indicated.
 - 3. Indicate on Record Drawings deviations from accepted Shop Drawing conductor identification.

1.5 QUALITY ASSURANCE

- A. Pre-installation Meeting:
 - 1. Conduct in accordance with Section 16000 and front-end specification..
 - 2. Purpose: To clearly define requirements specified for circuit/cable/conductor identification, hold a meeting including representatives of CONTRACTOR, DISTRICT, and ENGINEER prior to significant cable or conductor purchase and installation/termination.

PART 2 PRODUCTS

2.1 LABELS

- A. Manufacturers: One of the following or equal:
 - 1. Brady.
 - 2. Seton.
- B. Type: Sleeve type.

2.2 CONDUCTOR AND CABLE MARKERS

- A. Manufacturers: One of the following or equal:
 - 1. Brady.
 - 2. Seton.
- B. Type: Slip-on PVC sleeve.
- C. Printed using Brady marker "XC PLUS," or equal.
- D. Markers used in tunnels or other wet locations shall be on heat-shrinkable marking sleeves.
- E. Use self-laminating vinyl on white background for markers within electrical equipment such as panels, termination cabinets, motor control centers.
- F. Use engraved stainless steel tags with circuit designation fastened to direct buried cables in underground pull boxes as detailed on the drawings.

2.3 RACEWAYS IDENTIFICATION (TAGS)

- A. Conduit numbers shall be pressure stamped into a non corrosive 2 inch long, 1/2 inch wide stainless steel tape, Dymo marking system or equal. A tag with number shall be fixed with No. 18 AWG or larger type 304 stainless steel wire, to each conduit segment and at the end of each conduit and within 3 feet of each pull box, panelboard, and switchboard.

2.4 NAMEPLATES, LABELS AND SIGNS

- A. Nameplates:
 - 1. Type: Black lamicoid with white letters.
 - 2. Fastener: Round head stainless steel screws.
- B. Automatic Equipment and High Voltage Warning Signs:
 - 1. Type: Suitable for exterior use and meeting OSHA regulations.
- C. Power Pole Labels: Vinyl plastic with details as shown on the drawings.
 - 1. Manufacturers: One of the following or equal:
 - a. Brady.
 - b. Seton.
- D. Underground Hazard Tape: 6 inches wide.
 - 1. Manufacturers: One of the following or equal:
 - a. Panduit.
 - b. Thomas and Betts.

PART 3 EXECUTION

3.1 CIRCUIT IDENTIFICATION

- A. Identify 3-phase system conductors and cables as Phases A, B, and C and identify 1-phase system conductors and cables at electrical equipment including, but not limited to, switchgear, switchboards, panelboards, motor control centers, and motors.
 - 1. Match DISTRICT's existing electrical system identification scheme or meet requirements of the authority responsible for the project.
 - 2. 3-phase 480 Volts AC System Conductors: Phase A, brown; Phase B, orange; Phase C, yellow.
 - 3. Single-Phase Conductors for 120/240 VAC Circuits: Phase A, black; Phase B, red; Phase C, blue.
 - 4. Neutral Conductor: White for 120 VAC and gray for 277 VAC.
 - 5. Insulated Equipment Grounding Conductor: Green.
 - 6. General Purpose AC Control Conductors: Violet.
 - 7. General Purpose DC Control Conductors: Violet with white stripes.
 - 8. Where used, identify 15 kilovolt class cables with 3 stripes of color tape specified in item 3 above.
 - 9. Where used, identify 5 kilovolt cable with 2 stripes of color tape specified in item 3 above.

- B. Use color coding and phasing consistent throughout the site. Bus bars at panelboards and motor control centers to be connected Phase A-B-C, top to bottom, or left to right facing connecting lugs.
- C. Conductors Number 2 American Wire Gauge (AWG) and smaller to be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables to be coded by the use of colored tape.
- D. In addition to color coding, for all 1-phase and 3-phase systems, identify each cable (single or multi-conductor) and conductor at each end, in each manhole, pullbox, cable tray, or other component of the raceway system. This identification is applicable to all power, control, alarm, signal, instrumentation cables, and conductors.
- E. Identify each cable (single or multi-conductor) and groups or bundles of individual single conductors in each manhole, pullbox, cable tray, or other component of the raceway system with circuit identification markers. Implement a "from-to" cable/conductor bundle tagging system as part of this identification effort.
- F. Identify each individual conductor at each termination. This includes such locations as switchgear, switchboards, motor control centers, variable frequency drives, control panels, junction/terminal boxes, all field devices, and all other locations where conductors are terminated. Identify the termination of these conductors in accordance with the accepted Shop Drawings. Tag conductors with sleeve type labels.
- G. Where more than 1 nominal voltage system exists, identify each ungrounded system conductor by phase and system. Permanently post means of identification at each branch-circuit panelboard, switchboard, switchgear, motor control center, or other type of power distribution equipment.
- H. Include the following minimum information for wire and cable identification.
 - 1. Circuit number or load identification tag number as per section 16995.
 - 2. Origin (from source).
 - 3. Destination (to load).

3.2 NAMEPLATES

- A. Furnish and install nameplates for all electrical equipment indicated on the Drawings. Each disconnect control system, breaker, switch, panelboard, MCC, switchgear, switchboard etc., shall have nameplate indicating equipment name and circuit designation.
- B. Each disconnect means for service, feeder, branch, or equipment conductors and pushbutton stations shall have nameplates indicating its purpose or identifying the load.
- C. Each lighting switch and convenience outlet shall have a nameplate indicating its 120VAC power circuit number from lighting panelboard.

3.3 AUTOMATIC EQUIPMENT WARNING

- A. Mount permanent warning signs at mechanical equipment which may be started automatically or from remote locations. Fasten warning signs with round head stainless steel screws or bolts, located and mounted in a manner acceptable to ENGINEER.
- B. Mount permanent and conspicuous warning signs on (front and back) equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.
- C. Place a warning ribbon or other effective means suitable for conditions above ductbank underground installations.
- D. Place warning signs on utilization equipment that has more than one source of power. Provide panel and circuit number of conductor tag of the power source disconnect.
- E. Place warning signs on utilization equipment that has 120 VAC control voltage source used for interlocking. Provide panel, circuit number, and conductor tag of control voltage source disconnect.

3.4 CONDUIT TAGS

- A. Install conduit tags (engraved stainless steel round tags) at each conduit termination to control panel, MCC, enclosure, disconnect, pull box, junction box etc.. Conduit tag names shall be as per single-line with the source and circuit numbers, and control one-line diagrams shown on the drawings.

END OF SECTION

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SECTION 16123
600 VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. 600 Volt Class wire and cable.
 - 2. Instrumentation Class wire and cable.
 - 3. Fire Alarm wire and cable.
 - 4. Communication wire and cable.For fiber optic cables and datahighway cables as well as computer network cables, refer to Div 13.
- B. Related Sections:
 - 1. Section 16075 - Electrical Identification
 - 2. Section 16134 - Boxes.
 - 3. Section 16940 - Electrical Testing.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. B 3 - Standard Specification for Soft or Annealed Copper Wire.
 - 2. B 8 - Specification for Concentric-Lay–Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- B. Insulated Cable Engineers Association (ICEA).
- C. National Electrical Code (NEC):
 - 1. Article 250 - Grounding.
 - 2. Article 310 - Conductors for General Wiring.
 - 3. Article 760 - Fire Alarm Systems.
- D. Underwriter's Laboratories Inc., (UL):
 - 1. UL 1277 Subject - Electrical Power and Control Tray Cables with Optional Optical-fiber Members.

1.03 SUBMITTALS

- A. Shop Drawings: Show splice locations where allowed. Submit cable pulling calculations for all cable feeder larger than 2/0 AWG and pulling lengths longer than 200 feet. Submit cable pulling calculations for all conductor runs longer than 400 feet.
- B. Product Data: Include wires, cables, pulling compounds, and splicing materials.

1.04 QUALITY ASSURANCE

- A. Conform to ASTM and ICEA standards.

- B. Furnish mechanical conductor connector and heat-shrink type insulation by same manufacturer.

PART 2 PRODUCTS

2.01 WIRE AND CABLE MATERIALS

- A. Conductors: ASTM B 8, soft drawn copper, maximum 12 months old, minimum 97 percent conductivity. American Wire Gauge (AWG) sizes as indicated on the Drawings, Class B or C stranded.
- B. Insulation Thickness: Minimum specified by NEC Article 310.
- C. Conductor Sizes: As indicated on wiring schedules and Drawings.

2.02 600-VOLT CLASS CABLE

- A. Power Wire and Cable:
 - 1. Manufacturers: One of the following or equal:
 - a. Okonite Company.
 - b. BICC Cable.
 - c. Southwire
 - d. Rome Cable Corporation.
- B. Control Wire and Cable:
 - 1. Manufacturers: One of the following or equal:
 - a. Okonite Company.
 - b. BICC Cable.
 - c. Southwire.
 - d. Rome Cable Corporation.
- C. Insulation for Individual Wires or Multiple Conductor Cable for Power and Control Circuits:
 - 1. Type THHW-2 insulation for use in dry locations, wet locations and underground ductbanks.
- D. Jackets for Multiple Conductor Cable for Power and Control Circuits: Type CPE.
- E. Tray Cable (where used):
 - 1. Minimum size Number 1/0 AWG for single wires.
 - 2. Multi-conductor cable listed and identified on its surface as suitable for cable tray use, Type TC cable in accordance with NEC Article 318.
 - 3. Multi-Conductor Cables Requiring Connection to Neutral: Provided with integral white insulated conductor with ambient temperature adjustment in accordance with NEC Table 310-16.
- F. Multi-Conductor Cable Insulated Grounding Conductors:
 - 1. Color: Integral green.
 - 2. Sizes: In accordance with NEC 250-122.
- G. Solid-conductor wire, Number 12 AWG and smaller, shall not be used.

2.03 INSTRUMENTATION CLASS CABLE

- A. Single Pair or Triad Applications:
 - 1. Manufacturers: One of the following or equal:
 - a. The Okonite Company, Okoseal-N Type P-OS.
 - b. Equivalent manufactured by Cooper Industries, Belden Wire and Cable Division.
- B. Multiple Pair or Triad Applications:
 - 1. Manufacturers: One of the following or equal:
 - a. The Okonite Company, Okoseal-N Type SP-OS.
 - b. Equivalent manufactured by Cooper Industries, Belden Wire and Cable Division.
- C. Approved for cable tray installation in accordance with the National Electrical Code.
- D. Number of Individually Shielded, Twisted Pairs, and Triads: As indicated on raceway schedule or as necessary for the application.
- E. Voltage Rating: 600 volts.
- F. Cable Type: TC.
- G. Temperature Rating: 90 degrees Celsius dry location, 75 degrees Celsius wet location.
- H. Conductors: Bare, soft annealed copper in accordance with ASTM B 3, Class B, 7-strand concentric in accordance with ASTM B 8.
- I. Conductor Insulation: Flame-retardant polyvinyl chloride, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness, 90 degrees Celsius temperature rating in accordance with Underwriter's Laboratory Subject 1277.
- J. Color Code: Provide conductor color code as specified in Section 16075.
- K. Single Pair or Triad Shielding:
 - 1. Group Shielding: Minimum 1.35 mil double-faced aluminum/synthetic polymer-backed tape overlapped to provide 100 percent coverage.
 - 2. Drain Wire: 7-strand tinned copper drain wire, 2 sizes smaller than conductor.
- L. Multiple Pair or Triad Shielding:
 - 1. Group Shield: 1.35 mil aluminum-polyester tape overlapped to provide 100 percent coverage and a 7-strand tinned copper drain wire, 2 sizes smaller than conductor. Completely isolate group shields from each other.
 - 2. Cable Shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage and a 7-strand tinned copper drain wire, same size as conductors.
- M. Jacket: Black, flame-retardant in accordance with Underwriter's Laboratory Subject 1277, 90 degrees Celsius temperature rating, rip cord laid longitudinally under jacket to facilitate removal.

- N. Conductor Size: Number 16 AWG minimum unless otherwise indicated on the raceway schedule.
- O. Numerically identify one conductor within each pair and triad.

2.04 FIRE ALARM CABLE

- A. Manufacturers: One of the following or equal:
 - 1. Cooper Industries, Belden Wire and Cable Division.
 - 2. Houston Wire and Cable.
- B. Number of Pairs: As indicated on the raceway schedule or as necessary for the application.
- C. Voltage Rating: 300 volts.
- D. Cable Type:
 - 1. FPL - for use as fire protective signaling circuit cable in accordance with NEC Article 760.
 - 2. FPLR - for use in vertical cable runs from floor to floor in accordance with NEC Article 760.
- E. Conductors: ASTM B3, solid, soft, annealed copper, Number 14 AWG minimum.
- F. Conductor Insulation: Polyvinyl chloride rated 105 degrees Celsius.
- G. Jacket: Polyvinyl chloride rated 105 degrees Celsius.

2.05 COMMUNICATION CABLE

- A. Manufacturers: One of the following or equal:
 - 1. Cooper Industries, Belden Wire and Cable Division.
 - 2. American Telephone and Telegraph.
- B. Number of Twisted Pairs: As indicated on the raceway schedule
- C. Insulation: Thermoplastic, color coded in accordance with 16075.
- D. Jacket: High molecular weight polyethylene, surface printed with year of manufacture and cable description at maximum 24 inch intervals.
- E. Shield: 8 mil aluminum or copper, overlapped to provide 100 percent coverage, covered totally on both sides with copolymer or equal coating able to provide an effective moisture barrier.
- F. Inner Jacket: High molecular weight polyethylene, able to provide strength and surge barrier.
- G. Conductors: ASTM B3, solid, soft, bare copper.
- H. Conductor Size: Minimum Number 22 AWG, unless otherwise indicated on the raceway schedule.

- I. Fabrication:
 - 1. Twist insulated conductors into pairs with varying lengths of lay.
 - 2. Apply non-hygroscopic core tape over cable core as a dielectric and heat barrier.

2.06 RELATED MATERIALS

- A. Splicing Material:
 - 1. In conformance with ANSI C119.1, IEEE 383, and ICEA 5-19-81.
 - 2. Manufacturers: One of the following or equal:
 - a. Elastimold.
 - b. Thomas-Betts.
 - c. Raychem, FCSM Series.
- B. Wire Nuts:
 - 1. Rated 600 volt with live-spring feature for tight fitting connections.
 - 2. Manufacturers: One of the following or equal:
 - a. 3M.
 - b. Thomas and Betts.
- C. Junction Boxes and Terminal Cabinets: As specified in Section 16134.
- D. Pulling Compound: As recommended by conductor manufacturer.

2.07 WIRE AND CABLE FABRICATION

- A. Permanently mark American Wire Gauge (AWG) size, grade of insulation, voltage, and manufacturer's name on outer covering at maximum 24 inch intervals.
- B. Identify and mark conductors in accordance with NEC Article 310.
- C. Color code wire and cable as specified in Section 16075.
 - 1. Integrally color insulation for Number 2 AWG and smaller.
 - 2. Wrap colored tape around cable larger than Number 2 AWG.
- D. Fabricate cable ends with provisions for field testing.

2.08 SOURCE QUALITY CONTROL

- A. Test full lengths in accordance with ASTM and ICEA Standards.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install continuous circuit conductors from source to load without splices or terminations in intermediate manholes or pull boxes, except for Number 10 AWG and smaller conductors for lighting and receptacles.
- B. Splices:
 - 1. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths, install and label junction boxes for

power conductors or termination cabinets for control and instrument conductors. Underground pull boxes and manholes splices are not allowed. If allowed, they shall be done with 3M or equivalent splice kit with resin based materials rated and suitable for submersible application.

2. Power and control conductors routed in common raceways may be spliced in common junction boxes.
3. Install NEMA 4X junction and terminal boxes in wet and outdoor locations. Clearly label junction and terminal boxes containing splices with the word "SPICE."
4. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.

- C. Properly coat wires and cables with pulling compound before pulling into conduits and prevent mechanical damage to conductors during installation.

3.02 600-VOLT CLASS CABLE

- A. Size power conductors in accordance with National Electrical Code when sizes are not indicated on the raceway schedule.
- B. Install minimum Number 12 AWG wiring for power circuits unless otherwise specified or indicated on the raceway schedule, and minimum Number 14 AWG for control wiring unless otherwise specified.
- C. Install minimum 14 AWG for internal panel control wiring with type MTW or SIS insulation.
- D. Do not exceed cable manufacturer's pulling tension and side-wall pressures.
- E. Terminations and Splices (600 Volt or Less):
 1. Terminations: Terminate control and instrument conductors in terminal boxes in accordance with Section 16134-Boxes.
 2. Splicing: Join conductors mechanically with splice connectors and install heat-shrink type insulation. Splice conductors in accordance with manufacturer's instructions. Make waterproof heat shrink type splices in wet and below grade locations.
 3. Splice or weld grounding conductors of different sizes.
 4. Conductor Number 10 AWG and smaller for lighting and receptacle circuits may be spliced in junction boxes with wire nuts.
- F. All conductors for installation in underground duct banks, in sizes No. 10 AWG and smaller shall be of the multi-conductor type with overall jacket.
- G. All conductors of size No. 1/0 AWG and smaller for installation in cable trays and continuing without splices via other conduits; they shall be of the multi-conductor type with overall jacket.

3.03 INSTRUMENTATION CLASS CABLE

- A. Install instrumentation class cables in separate raceway systems.
 1. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.

2. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
- B. Do not make intermediate terminations, except in designated terminal boxes indicated on the Drawings.
- C. Ground cable shields at only one location, typically at panels, not at field instruments.

3.04 COMMUNICATION CABLE

- A. Install communication cables in dedicated raceways, including through ductbanks, manholes, and pull boxes.

3.05 SIGNAL CABLE AND CONDUIT INSTALLATION

- A. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

3.06 FIELD QUALITY CONTROL

- A. Testing: As specified in Section 16940.
- B. Grounding.

3.07 FIELD CONDITIONS AND RELATED REQUIREMENTS

- A. Existing underground water table is near or above the location for new ductbanks.
- B. Existing underground pull boxes, handholes, ductbanks, and manholes contain excessive amounts of water, conductors, and debris.
- C. CONTRACTOR shall include cost for necessary dewatering, equipment cost to identify raceways, and cleaning equipment to perform the work required for new underground ductbanks, manholes and pull boxes.
- D. CONTRACTOR shall include necessary cost to clean all underground ductbanks and pull boxes prior to installation of required new conductors.

3.08 WIRING ALLOWANCES

- A. CONTRACTOR shall include allowance of necessary conductors and termination to provide any and all motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of location shown on the Drawings.
- B. CONTRACTOR shall include allowance of necessary conductors and related materials to provide any and all pull boxes, manholes, and ductbanks within 20 linear feet of location shown on the Drawings.
- C. Prior installation of any raceway or related items identified in paragraphs A and B above, the OWNER shall have the right to make changes related to preferred location, at no additional cost.

- D. CONTRACTOR shall include allowance to provide necessary conductors for all equipment specified, identified in wiring/raceway schedules, equipment schedules, panelboards schedules, electrical single line diagrams, block diagrams, process and instrumentation diagrams (P&IDs), fixture schedules, and devices. Said necessary conductors may not be shown on the plan Drawings, but they shall be sized by CONTRACTOR in accordance with requirements of the National Electrical Code, and included in this allowance if the conductors are necessary for the complete operation of the included device or equipment.

3.09 RESTRAINING DEVICES FOR SUSPENDED CONDUCTORS

- A. Submersible cables in wet wells: Provide kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.
- B. Cable Fasteners: Provide plastic tie-wraps or alike cable fasteners to attach exposed or suspended cables to cabinets, building or structure.

END OF SECTION

SECTION 16134 BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Outlet boxes, device boxes, metallic pull boxes, junction boxes, termination boxes.
 - 2. Concrete pull boxes.
 - 3. Fasteners used with wiring devices.
- B. Related Sections:
 - 1. Section 16000 – Requirements for Electrical Work.

1.02 REFERENCES

- A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):
 - 1. OS1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - 2. OS2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- B. National Electrical Code (NEC):
 - 1. Article 370 - Outlet, Device, Pull and Junction Boxes, Conduit Bodies and Fittings.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.03 SUBMITTALS

- A. Product Data.
- B. Shop Drawings: Include identification and sizes of pull boxes for Owner's acceptance prior to fabrication and installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Device Boxes, Metallic Pull Boxes and Junction Boxes: One of the following or equal:
 - 1. Crouse-Hinds.
 - 2. Appleton.
 - 3. O-Z/Gedney
- B. Floor Outlet Boxes with 1 Inch Conduit Knockouts: One of the following or equal:

1. Steel City, 640 Series.
 2. Hubbell.
- C. Concrete Pull Boxes with Covers: One of the following or equal:
1. Quickset.
 2. Utility Vault Company.

2.02 DEVICE BOXES AND JUNCTION BOXES

- A. Materials: Heavy-duty rigid steel or rigid copper free aluminum, compatible with the location and conduit system being used, unless otherwise specified or indicated on the Drawings.
- B. For Indoor or Non-Corrosive Areas: Provide cast FD type device boxes with epoxy finish, and compatible with the location and conduit system being used.
- C. For Outdoor Locations, Corrosive Areas, or Wet Process Locations: Provide cast FD type boxes with PVC coating for outdoor locations, corrosive areas, and wet process locations compatible with the location and conduit system being used.
- D. Coverplates:
1. Indoor: Provide lighting switch and receptacle boxes of Type 302 stainless steel cover plates with cover gaskets, except where otherwise specified or indicated on the Drawings. Provide other boxes with Type 304 stainless steel cover screws and with cover gaskets.
 2. Outdoor and Corrosion Resistant: Provide lighting switch and receptacle boxes, weatherproof with yellow fiberglass lift cover plates with cover gaskets.

2.03 FLOOR OUTLET BOXES

- A. Suitable for receptacles, communications and data outlets as specified and indicated on the Drawings, complete with gaskets and cover plates.
- B. Dual-gang, heavy-duty cast iron, suitable for wiring devices to be installed to make a complete and operable system and installation.

2.04 CONCRETE PULL BOXES

- A. Precast concrete pull boxes in locations indicated on the Drawings and as required by NEC.
- B. Designed for heavy traffic conditions, with pull box and cover designed for heavy traffic bridge loading.
- C. Minimum 5 feet by 5 feet by 6 feet depth as necessary for ductbank depth, required with 3/4-inch diameter pulling irons located at each end. Constructed of reinforced Class A concrete. Larger size pull boxes shall be as shown on the drawings.
- D. Identification: Furnish covers with "Instrumentation" or "Electrical" engraved on top side. Covers shall be heavy-duty spring-aided reinforced galvanized steel .

2.05 METALLIC PULL BOXES

- A. Boxes for Applications in Dry and Non-Corrosive Location:
 - 1. Fabricated from 12 gauge (minimum) steel or aluminum, completely weatherproof with gasketed removable covers; compatible with type of conduit systems being used; manufactured, furnished, and installed complete with grounding lug.
- B. Boxes for Applications in Wet Areas, Outdoor Locations, and NEMA 4X Designated Areas: Fabricated from 12 gauge, 316 stainless steel, with gasketed covers and labeled NEMA 4X.
- C. Boxes in Locations Subject to Flooding, Temporary Submersion, or for Applications in NEMA 6 Designated Areas: Boxes shall be fabricated of cast aluminum, with gasketed cover, stainless steel cover screws, ground flange and listed NEMA 6.

2.06 FASTENERS

- A. Electroplated or stainless steel in boxes with wiring devices.
- B. Screws, Nuts, Bolts, and Other Threaded Fasteners: Stainless Steel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Comply with the National Electrical Code.
- B. Terminal blocks installed in junction/terminal boxes as specified in Section 16000.
- C. Install concrete pull boxes on 12 inches of compacted clean aggregate base course , and in such a manner that the cover of the pull box will be flush with finish grade.
- D. Provide weatherproof conduit hubs for all conduit connections to metallic pull boxes.
- E. Phosphatize and prime with rust-resistant paint metallic pull box surfaces. Finish shall be 2 coats of ANSI 61 gray enamel paint.
- F. Size pull boxes to meet National Electrical Code requirements and to provide sufficient room for the future conduits and cables indicated on the Drawings.
- G. Furnish and install pull boxes as indicated on the Drawings and as specified. Install additional pull boxes as required to meet cable manufacturer's pulling tension requirements.
- H. Install pull boxes such that access to them is not restricted by obstructions such as pipes, valves, ladders.
- I. Secure metallic pull box covers with Type 316 stainless steel screws or bolts with coated threads.

- J. Provide adequate supporting pillar(s) for boxes to be located above ground or above decks, where there is no structural wall or surface for box mounting.

3.02 ADJUSTMENT

- A. Adjust equipment as required.

END OF SECTION

SECTION 16145 CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cabinets and enclosures to house electrical equipment, electrical controls, instruments, terminal blocks, and similar equipment.
- B. Related Sections:
 - 1. Section 01300 - Submittal Procedures.
 - 2. Section 16000 – Requirements for Electrical Work.

1.2 REFERENCES

- A. National Electrical Code (NEC).
- B. National Electrical Manufacturers' Association (NEMA).

1.3 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Unless otherwise specified or indicated on the Drawings, enclosures to house electrical equipment, electrical controls, instruments, terminal blocks, and similar equipment shall be NEMA 12 for indoor, dry, and non-corrosive locations, and NEMA 4X (316 SS) for outdoor installations, wet locations, and corrosive designated areas, and shall be compatible with the conduit system being used.
 - 2. Specific control panel enclosures shall be as specified in DIVISION 13 of these Specifications or as indicated on the Drawings.
 - 3. For free-standing enclosure 3' wide or larger, provisions for seismic restrains shall be provided.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Submit product data and mounting supports.
- C. Calculations:
 - 1. Conditioning System Sizing: Submit calculations.

1.5 WARRANTY

- A. Submit manufacturer's standard warranty.
 - 1. Enclosures to house electrical controls, instruments, and equipment shall be NEMA 7 in hazardous-classified areas.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. NEMA 12 Steel Enclosures: One of the following or equal:
 - 1. Hoffman Engineering Company.
 - 2. Rittal.
- B. NEMA 4X Stainless Steel Enclosures: One of the following or equal:
 - 1. Hoffman Engineering Company.
 - 2. Henessy Products Inc.
 - 3. Carlon.
- C. NEMA 7 Enclosures: One of the following or equal:
 - 1. O-Z Gedney.
 - 2. Crouse Hinds
 - 3. Appleton
- D. Enclosure Air Conditioner: One of the following or equal:
 - 1. Hoffman Engineering Company.

2.2 FABRICATION

- A. NEMA 12 Steel Enclosures:
 - 1. Fabricate enclosures from 14 gauge steel with continuous welded seams.
 - 2. Doors: Doors shall have full length piano hinges with the door removable by pulling the hinge pin.
 - 3. Provide a rolled lip around 3 sides of the door and around all sides of the enclosure opening.
 - 4. Gaskets: Attach gasket with oil-resistant adhesive and hold it in place with steel retaining strips.
 - 5. Provide hasp and staple for padlocking.
 - 6. Provide a print pocket for each enclosure.
- B. NEMA 4X Stainless Steel Enclosures:
 - 1. Provide enclosures that consist of base and cover which shall be of Type 316 stainless steel with minimum thickness of 12 gauge. The enclosures shall be provided with cover hinges to form a weathertight seal between the cabinet and door.
- C. NEMA 7 Enclosures:
 - 1. Enclosures shall be of cast iron construction with o-ring gasket, hinges, and stainless steel cover bolts.
 - 2. Enclosures shall be custom built for specific application and provided with ample space for mounting and wiring electrical equipment.

2.3 FINISHES

- A. Steel Enclosures:
 - 1. Do not paint NEMA 4X enclosures. Door fronts shall be ground smooth.
 - 2. Print pockets and interior panels shall be steel with a white enamel finish.

3. Provide NEMA 12 and NEMA 4 enclosures with white enamel interior finish: The finish shall be light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Panels shall be white enamel.
 4. Special finishes and colors shall be furnished for wet locations.
- B. Other portions of these Contract Documents shall be checked for special conditions.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosures in accordance with manufacturer's instructions.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner. Install in accordance with Section 16000.
- C. Install cabinet fronts plumb.
- D. Top mounted air conditioning units installation shall not allow condensation to damage electrical equipment or enclosure.
- E. Provide size of pull boxes to meet National Electric Code requirements and ample space for conductors and devices.
- F. Provide adequate supports and anchors to resist seismic forces.
- G. Provide adequate supporting pillar(s) for cabinets to be located above decks, above slabs, or where there are no structural wall or surface for cabinet mounting.

END OF SECTION

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SECTION 16148 DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Fusible and nonfusible disconnect switches.

1.2 SUBMITTALS

- A. Product Data: Include manufacturer's specifications and description.
 - 1. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.
- B. Shop Drawings.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.3 WARRANTY

- A. Submit manufacturer's standard warranty.

1.4 MAINTENANCE

- A. Spare Parts: Furnish 1 set of spare fuses for each fused disconnect switch.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Disconnect Switches: One of the following or equal:
 - 1. Square D Company.
 - 2. Cutler-Hammer.

2.2 DISCONNECT SWITCHES

- A. Type:
 - 1. Heavy-duty, industrial grade safety switches, NEMA rated with a quick-make, quick-break operating mechanism, full cover interlock and indicator handle.
 - 2. Where required, furnish with fuses where indicated on the Drawings.
- B. Unless otherwise specified herein or indicated on the Drawings, disconnect switches shall be in NEMA 12 enclosures for indoor installations and in NEMA 4X (316 SS) enclosures for outdoor installations and in corrosive, chemical areas.
 - 1. Disconnect switch enclosures shall be compatible with type of conduit system being used.

- C. Provide nameplates as specified elsewhere in these specifications.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install devices in accordance with manufacturer's instructions and accepted shop drawings.
- B. For packaged equipment, all 480V and 120V devices shall be provided with local disconnect switches.
- C. Provide adequate supporting pillar(s) for disconnect switches to be located above ground or above decks, where there is no structural wall or surface for box mounting.

END OF SECTION

SECTION 16153 LOW VOLTAGE CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Low voltage circuit breakers as indicated on the Drawings and as specified.
- B. Related Sections:
 - 1. Section 16000 – Requirements for electrical work.
 - 2. Section 16920 - 600 Volt Motor Control Centers.
 - 3. Section 16938 – Power System Study.

1.2 REFERENCES

- A. National Electrical Manufacturers Association (NEMA): Standards Publication No. AB1.
- B. National Electrical Code (NEC): Article 430-52.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Circuit Breakers: Manufacturers: One of the following or equal:
 - 1. Cutler-Hammer.
 - 2. General Electric Company.
 - 3. Square D
- B. Motor Circuit Protectors: One of the following manufacturers or equal:
 - 1. Cutler-Hammer.
 - 2. General Electric Company.
 - 3. Square D

2.2 CIRCUIT BREAKERS - LOW VOLTAGE

- A. Circuit Breaker Frame and Trip Ratings: As indicated on the Drawings and coordinated with the ratings of the equipment actually furnished. Modify ratings where necessary to suit this equipment and in accordance with the short circuit fault analysis and protective device coordination study required in Section 16938.
- B. Circuit Breakers for Motor Control Centers: As specified and indicated on the Drawings. Where no indication of type is given on the Drawings, the following governs:
 - 1. When an integral part of a UL-listed combination controller: Motor circuit

- protectors.
2. All other circuit breakers: Molded case circuit breakers.
- C. Provide motor circuit protectors and circuit breakers with non-aluminum line and load terminals suitable for the required conductor type, size, and number of conductors.
 - D. Panelboard Circuit Breakers: Bolt-in type. Snap-in circuit breakers are not acceptable.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Molded-case Circuit Breakers: Ambient compensating which provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Accomplish compensation by a secondary bimetal that will allow the breaker to carry rated current between 25 degrees Centigrade and 50 degrees Centigrade with tripping characteristics which are approximately the same throughout this temperature range. All molded-case circuit breakers shall be lockable.
- B. Circuit Breaker Ratings and Modifications: As indicated on the Drawings. Breakers rated at 200 amperes or higher shall be provided with a solid-state trip units having long time, short time, instantaneous, and ground fault protections. For breakers rated 400 amperes or higher, full function electronic trip unit with adjustable plug, long time, long time delay, short time, short time delay, instantaneous, ground fault, ground fault delay protection shall be provided.
- C. On Breakers with Interchangeable, Thermal, Adjustable Magnetic Trip: The accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.
- D. Circuit Breakers for Mounting in Motor Control Centers or for Separate Mounting: Air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Drawings. Minimum Frame Size: 100 amperes.
 1. Provide each breaker pole with inverse time delay and instantaneous circuit protection.
- E. Breakers: Operated by a handle and provided with a quick-make, quick-break switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents.
 1. Tripping Due to Overload, Short Circuit, or Ground Fault: Clearly indicate tripping by the handle automatically assuming a position between the manual ON and OFF positions.
 2. Latch Surfaces: Ground and polished.
 3. Poles: Constructed so they all open, close and trip simultaneously.
 4. Conform to the applicable requirements of NEMA Standard No. AB1.
- F. Breakers: Completely enclosed in a molded case.
 1. Non-interchangeable Trip Breakers: Sealed covers.
 2. Interchangeable Trip Breakers: Sealed trip unit to prevent tampering.
 3. Ampere Ratings: Clearly visible.

4. Contacts: Non-welding silver alloy.
 5. Arc Extinction: Accomplished by means of arc chutes.
- G. Minimum Interrupting Ratings: At least equal to the available short circuit at the line terminals as determined by the CONTRACTOR's short circuit fault analysis and as accepted by the ENGINEER, but not less than 65,000 RMS amperes.

2.4 MOTOR CIRCUIT PROTECTORS

- A. Motor Circuits: Protected by motor circuit protectors, as permitted by Item I below.
- B. Motor Circuit Protectors: Operated by a handle and provided with a quick-make, quick-break switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents.
1. Tripping: Clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions.
 2. Latch Surfaces: Ground and polished.
 3. Poles: Constructed so they all open, close, and trip simultaneously.
- C. Motor Circuit Protectors: Completely enclosed in a molded case.
1. Trip Unit: Sealed to prevent tampering.
 2. Ampere Ratings: Clearly visible.
 3. Contacts: Non-welding silver alloy.
 4. Arc Extinction: Accomplished by means of arc chutes.
- D. Provide each pole of motor circuit protectors with instantaneous short circuit protection by means of a single adjustable magnetic only element. The single adjustment screw is to adjust all poles simultaneously.
- E. Furnish motor circuit protectors with provision for locking the maximum achievable trip setting to values less than maximum obtainable trip setting. Each adjustment typically to have 8 main setting points and mid-setting points following a linear scale so that each point has a significant value within calibration tolerances.
- F. Motor Circuit Protectors: Suitable for use with current limiters, having 100,000 ampere interrupting capacity and a built-in trip indicator, that are fully coordinated with the motor circuit protectors so that the motor circuit protectors will open all 3 phases if the limiter operates.
1. Current limiters shall be so constructed that they can only be replaced by an identical or similar limiter having the same interrupting capacity.
- G. Minimum Interrupting Rating: At least equal to the available short circuit current at the line terminals as determined by the CONTRACTOR's short circuit fault analysis as accepted by the ENGINEER, but not less than 65,000 RMS amperes.
- H. Motor Circuit Protectors Continuous Current Rating: As specified herein or as indicated on the Drawings.
1. Setting: The motor circuit protectors setting shall be in accordance with the

CONTRACTOR's protective device coordination study as accepted by the ENGINEER and in accordance with the motor circuit protectors manufacturer's recommendation based on motor nameplate current or actual motor current, whichever is larger.

- I. Utilize an instantaneous trip circuit breaker or motor circuit protector only as part of a listed combination motor controller which provides coordinated motor branch-circuit overload, and short-circuit and ground-fault protection in accordance with NEC Article 430-52.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install breakers per the manufacturer's recommendations and contract Drawings.

3.2 FIELD TESTING AND SETTINGS

- A. Perform field adjustments and testing of the circuit breaker as necessary for the final operating condition. The setting shall be in accordance with the approved protective device coordination study.

END OF SECTION

SECTION 16155 MOTOR CONTROL

GENERAL

1.1 SUMMARY

- A. Section Includes: Manual starters, magnetic contactors, overload relays, combination starters and related motor controllers.
- B. Related Sections:
 - 1. Section 16000 – Requirements for Electrical Work
 - 2. Section 16920 – 600V Motor Control Center

1.2 REFERENCES

- A. National Electrical Code (NEC):
 - 1. Article 430 - Motors, Motor Circuits and Controllers.
- B. National Electrical Manufacturers Association (NEMA).

1.3 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 16000.
- B. Manufacturer's installation instructions.

1.4 WARRANTY

- A. Submit manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manual Motor Starters: One of the following or equal:
 - 1. Square D Company.
 - 2. Cutler-Hammer.
 - 3. General Electric.
 - 4. Eaton
- B. Full Voltage Magnetic Starters: One of the following or equal:
 - 1. Cutler-Hammer.
 - 2. Allen-Bradley.
 - 3. Square D Company.
 - 4. Eaton
- C. Reduced Voltage Closed-transition Autotransformer Starters: One of the following or equal:

1. Cutler-Hammer.
2. Square D Company.
3. Allen-Bradley.
4. Eaton

2.2 STARTERS

- A. Suitable for the horsepower ratings specified, and in accordance with NEC Article 430.
- B. Verify motor ratings and coordinate starter and overload trip ratings with actual horsepower and nameplate current ratings of motors installed.
- C. Magnetic Contactors: Factory adjusted and chatter free.
- D. Overload Relays: Install bimetallic type overload relays in each line conductor as indicated on the Drawings. Provide contacts for remote monitoring of overload status as indicated on the Drawings.
- E. Mount extended overload reset buttons to be accessible for operation without opening door of enclosure. Plastic overload relay reset buttons with plastic operator shafts are unacceptable.
- F. Provide starters Size 2 and larger with arc quenchers on load breaking contacts.
- G. Minimum Size Starter: NEMA Size 1, and not smaller than size indicated on the Drawings.
- H. Provide starters of sufficient size to accommodate motors furnished, including larger starters required for larger motors supplied by CONTRACTOR.
- I. Combination Starters: Furnish complete with a 120 volt control transformer and accessories unless otherwise noted.
- J. Control Fuses: Size and furnish as required and where indicated in the schematics.

2.3 MANUAL MOTOR STARTERS

- A. Across-the-line manual motor starters for motors up to 1 horsepower, 600 volts shall have the electrical characteristics indicated on the Drawings.
- B. Provide single-pole or 3 pole as indicated on the Drawings with overload devices.
- C. Provide handles that clearly indicate the ON, OFF with lockout, and TRIPPED positions, pilot light, and positive, quick-make, quick-break mechanisms.
- D. Provide enclosures as indicated on the Drawings. Where not indicated, provide NEMA 12 enclosures for indoor location and NEMA 4X (316 SS) stainless steel enclosures for outdoor locations and corrosive, chemical areas. Provide enclosures compatible with type of conduit system being used for each specific application.

2.4 FULL VOLTAGE MAGNETIC STARTERS

- A. Across-the-line full voltage magnetic starters for up to 600 volts shall have electrical characteristics indicated on the Drawings.
- B. Provide positive, quick-make, quick-break mechanisms; padlockable enclosure doors; 3 overload relays with plus or minus 15 percent adjustment from nominal heater rating on the overload relay; cover mounted reset button, and at least 3 reversible contacts in addition to hold-in contact.
- C. Provide magnetic starter enclosures as indicated on the Drawings. Where not indicated, provide NEMA 12 enclosures for indoor locations and NEMA 4X stainless steel enclosures for outdoor locations and corrosive, chemical areas. Provide enclosures compatible with type of conduit being used for each specific application.
- D. Provide magnetic starters in accordance with latest NEMA Standards.
- E. Provide pilot devices such as push buttons, pilot lights (push-to-test type), running time meter, motor protector modules as shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install motor starters in accordance with section 16000.

3.2 APPLICATION

- A. Supply circuit breaker trip elements and starter overload trip elements to meet above normal ambient temperatures where such conditions are anticipated (subject to ENGINEER's acceptance).

3.3 DEMONSTRATION

- A. Demonstrate successful operation of equipment.

3.4 PROTECTION

- A. Protect products until acceptance by DISTRICT.

END OF SECTION

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SECTION 16159 PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Dead-front panelboards, including lighting distribution and control panelboards.
- B. Related Section:
 - 1. Section 01300 - Submittal Procedures.
 - 2. Section 16075 - Electrical Identification.
 - 3. Section 16153 - Low Voltage Circuit Breakers.
 - 4. Section 16940 - Electrical Testing.

1.2 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
- B. Underwriter's Laboratories, Inc. (UL):
 - 1. UL 67 - Panelboards.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Interrupting Capacity of Device: Equal to available short circuit current at line terminals as determined by CONTRACTOR's short circuit fault analysis as accepted by ENGINEER, but not less than 22,000 amperes.
- B. Provide main bus rating of panelboards, number of poles, and provisions for number of circuits as indicated on the Drawings.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's specifications and description.
- B. Shop Drawings: Submit in accordance with Section 01330. Include panelboard layout.

1.5 WARRANTY

- A. Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Panelboards: One of the following or equal:

1. Cutler-Hammer.
 2. Square D Company.
 3. General Electric Company.
 4. Allen-Bradley.
- B. The manufacturer of the panelboard shall make all major components, including circuit breakers.

2.2 INTERIOR

- A. Bus: Size main bus bars in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees Centigrade above specified ambient maximum.
1. Tin-plated copper bussing.
- B. Install protective devices such that they can be replaced without disturbing adjacent units. Wire connectors shall be suitable for wire sizes indicated on the Drawings.
- C. Number branch circuits and spares as indicated on the Drawings and furnish complete typed circuit schedule in directory cardholder affixed to panel under a transparent cover.
- D. Phase busing shall be full size and height without reduction. Include full size neutral bars with suitable lugs for the maximum number of circuits, which can be connected to the panel.
- E. Spares and spaces for future protective devices in panels indicated on the Drawings shall be bussed for panel rating or the main circuit breaker rating.
- F. Provide panels with tin-plated copper ground bus separate from neutral bars. Ground bus to have suitable lug for each circuit breaker installed including future circuits.
- G. Provide directory holder pocket to hold typed circuit directory. Glue-on type holder is NOT acceptable.

2.3 ENCLOSURES

- A. Size panelboards sufficiently to provide minimum 4 inches of gutter space on all sides. Doors shall be such that:
1. Live parts shall not be exposed when circuit breakers or switches are put in service.
 2. Hinges and latches shall not require tools to operate.
- B. Furnish lock and minimum 2 keys each panelboard. Key all panelboard locks alike.
- C. Enclosure type as indicated on the Drawings. Where not indicated on the Drawings:
1. Indoor Enclosures: NEMA 12.

- 2. Outdoor and Corrosive Areas Enclosures: 316 Stainless steel NEMA 4X.
 - D. Mounting shall be as indicated on the Drawings.
 - E. For NEMA 12 panelboards, finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat and 2 coats of oven-baked enamel with finish color ANSI 61 gray or a color to be selected by the ENGINEER.
 - F. For NEMA 12 panelboards, finish motor control center mounted panelboards to match the MCC finish and color, unless directed otherwise.
- 2.4 CIRCUIT BREAKERS
- A. Circuit Breakers: As specified in Section 16153.
 - B. Provide handle locks on all circuit breaker supplying exit signs, emergency lights, and fire alarm panels.
- 2.5 IDENTIFICATION
- A. Label panelboards to indicate use as service entrance equipment where indicated on the Drawings or specified.
 - B. Label panelboards with UL short circuit current rating.
 - C. Provide each panelboard, which is not an integral part of a motor control center with a lamicoid nameplate on outside of door, as specified in Section 16075, Electrical Identification.

PART 3 EXECUTION

3.1 INSTALLATION

- A. As indicated on the Drawings, or as required, in a workmanlike manner.
- B. Terminate conduits towards backside of panelboard allowing top and bottom access for future conduits.
- C. Provide a typed circuit directory indicating circuit numbers and names of loads served.

3.2 FIELD QUALITY CONTROL

- A. Test main circuit breaker(s) as specified in Section 16940.

3.3 SUPPORTS

- A. Review architectural and structural drawings to determine the available wall for installation of panelboard.
- B. Installation on cast-in-place concrete or masonry walls shall include a 3/4" marine

plywood and painted backboard.

- C. Installation on drywall partitions shall include supplemental support for large panelboard. Provide additional channel frame anchorate to floor.
- D. Do not install any devices or equipment directly above panelboards except conduits.
- E. Provide channel frame to the equipment pad and weld.

END OF SECTION

SECTION 16160 LIGHTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Lighting fixtures, lamps, ballasts, poles, and accessories.
- B. Related Sections:
 - 1. Section 16000 – Requirements for Electrical Work

1.2 REFERENCES

- A. Underwriter's Laboratories (UL):
 - 1. UL 1029 - High-Intensity Discharge Lamp Ballasts.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, beam lumens.
 - 2. Submit pole seismic and wind-load design calculations before fixtures and poles are manufactured.
 - 3. Anchor concrete bases for lighting poles.
- B. Samples: Include finish sample for lighting fixtures and poles.
- C. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Lighting Fixtures: As noted in section 16000
- B. Lamps: One of the following:
 - 1. General Electric Company.
 - 2. GTE Sylvania Lighting.
 - 3. Philips Lighting Company
- C. Ballasts for Fluorescent Lamps: One of the following solid-state or equal:
 - 1. Advance
 - 2. Holophane
 - 3. Lithonia
 - 4. Hubble.
 - 5. Universal.

6. GTE Sylvania Lighting.

D. Ballasts, HID Lamps: One of the following or equal:

1. Advance.
2. Holophane.
3. GTE's Sylvania Lighting.

E. Plugs and Receptacles: As specified in Section 16000.

2.2 FIXTURES

A. Lighting Fixtures: As described in section 16000.

1. Fixtures shall include lamps, ballasts, poles, mounting hardware, and appurtenances to provide complete operating units.

B. Fluorescent Lamps:

1. Electronic type.
2. T8 type, 32W; 2900 lumens.

C. HID Lamps:

1. Metal halide or High Pressure Sodium.

D. Compact Fluorescent Lamps:

1. Minimum 25W rated.

2.3 BALLASTS

A. General:

1. Energy saving type suitable for use with energy saving lamps.
2. High power factor type, with power factor not less than 90 percent.
3. Cold weather (low temperature) rated for outdoor use.
4. Internally fused ballast.

B. Ballasts for Fluorescent Lamps:

1. Bear CBM and ETL labels certifying that ballasts meet pertinent requirements.
 - a. Electronic ballasts for T8 32W.
 - b. Energy saving ballasts for T12 40W lamps.
2. Contain a built-in thermal protector to disconnect ballast permanently prior to failure, or be fused.
3. High efficiency and constant wattage type.
4. Of 2 windings where required by applicable codes.
5. Use dimming ballasts with dimmer controlled fluorescent fixtures where indicated on the Drawings.
6. Rated for location of installation.

C. Ballasts for High Intensity Discharge Lamps:

1. Meet requirements of UL 1029.
2. UL listed, UL labeled, or UL recognized.
3. Copper windings.
4. Be internally fused.

2.4 CONTROL TIMER

- A. Electromechanical type 7-day with skip a day functions

2.5 LIGHTING CONTACTORS

- A. Silver-cadmium-oxide, double-break contacts.
- B. 30 ampere rating for lighting circuits.
- C. Mechanically held.
- D. Number of poles as indicated on the Drawings with a minimum of 4 poles and a maximum of 12 poles for each contactor provided.
- E. Manufacturers: One of the following or equal:
 - 1. Square D Company, Type LX.
 - 2. ASCO, Model 917.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Surface and Flush Mounted Fixtures: Solidly connected to a junction box.
- B. Suspended Fixtures: Hung utilizing pendant mounting or stainless steel chains and hooks. Electrically connect each fixture, or row of fixtures, and by rigid conduit and flexible conduit. Provide adequate supports with seismic restraints.
- C. Pole Mounted Fixtures: Mount on steel, aluminum, or fiberglass poles as described in Lighting Fixture Schedule and as indicated on the Drawings.
 - 1. Ground or bond metal poles to the plant grounding system.
 - 2. Poles shall have adequate handholes in accordance with NEC requirements.
 - 3. Poles shall have weatherproof switches, receptacles, photo cells where indicated on the Drawings.

3.2 SPARES

- A. Fixtures and Mounting Accessories: 1 spare for each type.

3.3 LIGHTING FIXTURE SCHEDULE

- A. As indicated on the drawings.

3.4 PROTECTION

- A. Protect products until accepted by District.

END OF SECTION

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SECTION 16222 MOTORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Single phase motors, direct current motors, and 3-phase motors up to and including 400 horsepower.

1.2 REFERENCES

- A. American Bearing Manufacturers Association (ABMA):
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Institute of Electrical and Electronic Engineers (IEEE).
- C. National Electrical Manufacturers' Association (NEMA):
 - 1. MG-1 - Motors and Generators.

1.3 DEFINITIONS

- A. Solid-State Motor Controller: Includes variable frequency drives and solid-state reduced voltage starters.
- B. Nominal Efficiency: The average full load efficiency value of a large population of the manufacturer's motors of the same design.
- C. Minimum Efficiency: The minimum full load efficiency value of any individual motor associated with the nominal motor efficiency.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Descriptive bulletins.
 - 2. Outline Drawings with dimensions.
 - 3. Cut-away and exploded view Drawings.
 - 4. Parts list with material designations.
 - 5. Nameplate data.
 - 6. Motor weight, frame size, and conduit box location.
 - 7. Description of insulation system.
- B. Design and Performance Data:
 - 1. Bearing design and bearing life calculations.
 - 2. Performance Data Required by Schedule A, Nameplate Data, and Following Information:
 - a. Service factor.
 - b. Efficiency at 1/2 and 3/4 load.

- c. Power factor at 1/2 and 3/4 load.
 - d. When required for power factor improvement, capacitor size in KVAR with calculation data for motors sized 50 horsepower and above.
- 3. Special features including condensation heaters and winding temperature detectors.
- 4. Performance data for motors with synchronous speed of 900 revolutions per minute and below.
- 5. Factory test reports with test reference standard identified.

1.5 QUALITY ASSURANCE

- A. Certification:
 - 1. When motors are driven by variable speed drive systems, submit certification that selected motor:
 - a. Is capable of satisfactory performance under the intended load.
 - b. Is suitable for operation with the proposed variable speed drive unit.
- B. Rating:
 - 1. All motors provided for this project shall be suitable for an elevation of 1,250 feet without derating.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Motors: One of the following or equal:
 - 1. U. S. Motors.
 - 2. General Electric.
 - 3. Reliance.

2.2 ELECTRICAL MOTORS

- A. General:
 - 1. Manufactured with cast iron frames in accordance with NEMA MG 1, and in accordance with specified requirements.
 - 2. Alternating Current Motors: Squirrel cage induction type suitable for 60 hertz power.
 - 3. Where not otherwise specified or indicated on the Drawings:
 - a. Motors 1 Horsepower and Larger: 3-phase, 460 volt.
 - b. Motors less than 1 Horsepower: Single phase, 120 volt.
 - 4. 2-Speed Motors: Dual winding design.
 - 5. Temperature Rating and Altitude Requirements: Where not otherwise specified or indicated on the Drawings, provide motors that are rated suitable for continuous operation in 40 degree Celsius ambient temperature at project site altitude.
 - a. Temperature Rise Under Full Load: Not to exceed that for Class B insulation (80 degrees Celsius).
 - 6. Motor Data: Specific motor data including horsepower, speed, and enclosure type are indicated on the Drawings and specified under equipment for which motor is required.
 - 7. Torque and Power of Motors:

- a. Provide motors that develop sufficient torque for required service throughout acceleration range at voltage 10 percent less than motor nameplate rating.
 - b. Provide motors that develop sufficient torque when started using reduced voltage starters.
 8. Motor Leads and Insulating Material: Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
 9. Grounding Lugs: Provide inside conduit boxes for motor frame grounding.
 10. Hardware: Type 316 stainless steel.
 - B. Provide motors that are special premium efficiency type, except motors that are to be used on hoisting equipment, heat pumps, unit heaters, sump pumps, and lubricating oil transfer pumps.
 1. Provide premium efficiency type motors having nominal full load efficiencies and power factors as specified in Schedule A appended to this Section.
 2. Actual full load efficiency of individual motors within the nominal efficiency band shall not be less than the minimum efficiency value specified in Schedule A.
 - C. Condensation Heaters:
 1. Use: Required in motors in outdoor applications.
 2. Type: Cartridge or flexible wrap-around type installed within motor enclosure adjacent to core iron.
 3. Rating, Phase and Wattage: Rated for 120 volt, single phase with wattage as required.
 4. Bring power leads for heaters into conduit box.
 - D. Winding Temperature Detectors:
 1. When specified for individual equipment and on alternating current motors connected to a solid-state motor controller, provide factory installed winding temperature detector with leads terminating in conduit box.
 2. Provide detectors that protect motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts, or ventilation failure.
 - a. For Motors Less than 200 Horsepower: Provide detector that has normally closed contacts.
 - b. For Motors 200 Horsepower and Larger: Provide with resistance temperature detectors, 2 per each phase.
 3. Auxiliary Relays and Controls: Provide relays and controls and mount them in controller enclosure which is suitable for the environment.
 - E. Internal Cooling Motors: Design motors having speeds of 900 revolutions per minute and less, and motors that are connected to solid-state motor controllers with special attention to internal cooling.
- 2.3 SINGLE PHASE MOTORS
- A. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or indicated on the Drawings.
 - B. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG 1-10.35.

- C. Ball Bearings: Sealed.
- D. 1/2 Horsepower or Less Fan Motors:
 - 1. Split-phase or shaded pole type when standard for the equipment.
 - 2. Open type when suitably protected from moisture, dripping water, and lint accumulation.
- E. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the ENGINEER.

2.4 3-PHASE MOTORS

- A. Suitable for 460 volt 3-phase power unless otherwise specified or indicated on the Drawings.
- B. NEMA Design B except where driven load characteristics require other than normal starting torque.
 - 1. Starting kilovolt ampere per horsepower (locked rotor) are not to exceed values specified in NEMA MG-1-10.37.
- C. Motor Bearings: Antifriction, regreasable, and filled initially with grease suitable for ambient temperatures to 40 degrees Celsius.
 - 1. Suitable for intended application and have ABMA B-10 rating life of 60,000 hours or more.
 - 2. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
 - 3. Provide two pole motors with sleeve type bearings.
- D. Insulation Systems:
 - 1. Comply with NEMA 1-1.65.
 - 2. Class F system with Class B temperature rise.
 - 3. Resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.
- E. Conduit Boxes: Cast iron or stamped steel, split from top to bottom and capable of being rotated to 4 positions.
 - 1. Provide gaskets between following:
 - a. Frames and conduit boxes.
 - b. Conduit boxes and box covers.
- F. Motor Enclosures: When enclosure type is not specified in individual equipment specifications, provide a Totally Enclosed Fan Cooled (TEFC) enclosure for non-hazardous (unclassified) areas and explosion-proof enclosure for hazardous (classified) areas:
 - 1. Totally Enclosed Fan Cooled: Cast iron conduit box; 1.15 service factor at 40 degrees Celsius ambient; tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger; upgraded insulation by minimum of 3 dips and bakes and sealer coat of epoxy or silicone.
 - 2. Explosion-Proof: 1.15 service factor at 40 degrees Celsius; tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and

drain devices for frames 324T and larger; UL label for Class I, Division 1, Group D hazardous area.

3. For special application such as corrosive environment, use a Severe Duty motor. Corrosion resistant type conforming to motors designated by manufacturer as "Chemical Duty," "Mill and Chemical," "Custom Severe Duty," or similar applicable manufacturer's quality designation with 1.15 service factor at 40 degrees Celsius; tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger; epoxy finish; and upgraded insulation using encapsulated or dip and bake windings.
4. Submersible: Watertight casing with insulated windings which are moisture resistant.
 - a. Pump Motors Specified to be Submersible: Provide motors having cooling characteristics suitable for continuous operation in totally, partially, or non-submerged condition without overheating or other damage.
 - b. Electrical Cables: Provide cables of adequate length to allow unit to be wired without splices.
5. Open Drip Proof where specified elsewhere: Stamped steel conduit boxes; 1.15 service factor at 40 degrees Celsius.

2.5 MOTOR SIZES

- A. Motor sizes specified in the Specifications and indicated on the Drawings are minimum sizes.
- B. Provide motors, electrical circuits, and equipment of ample horsepower capacity to operate equipment without exceeding rated nameplate horsepower, full-load current at rated nameplate voltage, or overheating at maximum load capacity.

2.6 SOURCE QUALITY CONTROL

- A. Factory Testing of 3-Phase Motors:
 1. When specified in individual equipment Specifications, factory test motors. Include testing of:
 - a. No load current.
 - b. Locked rotor current.
 - c. Winding resistance.
 - d. High potential.
 2. Perform in accordance with applicable NEMA Standards.
 3. Furnish copies of test reports.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with manufacturer's instructions.

3.2 SCHEDULES

- A. Schedule A: Full load motor efficiency and power factor rating requirements for premium efficiency, 460 volt, 3-phase horizontal motors.

SCHEDULE A

**FULL LOAD MOTOR EFFICIENCY AND POWER
FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY,
460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS**

		Protected (Open Drip Proof) ⁽¹⁾			Totally Enclosed Fan Cooled ⁽¹⁾		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
1	1,800	81.5	84.0	70.9	81.5	84.0	77.7
	1,200	78.5	81.5	57.0	78.5	81.5	57.0
2	3,600	81.5	84.0	87.7	84.0	86.5	87.7
	1,800	81.5	84.0	76.7	81.5	84.0	78.8
	1,200	84.0	86.5	68.1	85.5	87.5	68.1
3	3,600	80.0	82.5	90.4	84.0	86.5	82.8
	1,800	86.5	88.5	78.9	86.5	88.5	79.2
	1,200	87.5	89.5	71.0	87.5	89.5	71.0
5	3,600	86.5	81.5	84.5	86.5	88.5	87.0
	1,800	87.5	88.5	80.4	86.5	88.5	81.0
	1,200	88.5	89.5	73.0	87.5	89.5	74.4
	900	87.5	87.5	70.0	87.5	89.5	70.5
7-1/2	3,600	86.5	88.5	86.7	87.5	89.5	86.3
	1,800	87.5	89.5	83.3	88.5	90.2	84.4
	1,200	88.5	90.2	78.2	88.5	90.2	78.3
	900	87.5	89.5	72.0	87.5	89.5	72.0
10	3,600	88.5	90.2	85.5	89.5	91.0	87.5
	1,800	88.5	90.2	82.8	88.5	90.2	86.0
	1,200	89.5	91.0	80.5	89.5	91.0	81.0
	900	89.5	91.0	75.8	88.5	90.2	76.0

<u>SCHEDULE A</u> FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS							
		Protected (Open Drip Proof) ⁽¹⁾			Totally Enclosed Fan Cooled ⁽¹⁾		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
15	3,600	88.5	90.2	86.7	89.5	91.0	87.4
	1,800	90.2	91.7	81.9	91.0	92.4	82.7
	1,200	89.5	91.0	81.7	90.2	91.7	78.9
	900	89.5	91.0	76.8	88.5	90.2	77.0
20	3,600	90.2	91.7	87.1	90.2	91.7	88.7
	1,800	91.0	92.4	83.1	91.0	92.4	84.2
	1,200	90.2	91.7	83.7	90.2	91.7	79.0
	900	90.2	91.7	77.2	89.5	91.0	77.2
25	3,600	90.2	91.7	88.1	91.0	92.4	85.5
	1,800	91.7	93.0	82.7	92.4	93.6	84.3
	1,200	91.0	92.4	79.2	91.0	92.4	83.5
	900	90.2	91.7	76.3	90.2	91.7	76.4
30	3,600	91.7	93.0	88.3	91.0	92.4	73.9
	1,800	91.7	93.0	83.3	92.4	93.6	83.1
	1,200	91.7	93.0	82.1	91.7	93.0	83.5
	900	91.7	93.0	76.0	91.0	92.4	76.5
40	3,600	92.4	93.6	89.2	92.4	93.6	87.5
	1,800	93.0	94.1	80.8	93.0	94.1	82.3
	1,200	92.4	93.6	82.2	92.4	93.6	80.5
	900	91.7	93.0	75.0	91.7	93.0	75.5

<u>SCHEDULE A</u> FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS							
		Protected (Open Drip Proof) ⁽¹⁾			Totally Enclosed Fan Cooled ⁽¹⁾		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
50	3,600	91.7	93.0	86.3	91.7	93.0	87.7
	1,800	93.0	94.1	83.3	93.0	94.1	84.2
	1,200	92.4	93.6	83.0	92.4	93.6	80.6
	900	92.4	93.6	79.2	91.7	93.0	79.5
60	3,600	92.4	93.6	88.8	92.4	93.6	88.9
	1,800	94.1	95.0	84.5	94.1	95.0	84.2
	1,200	93.6	94.5	84.4	93.0	94.1	85.4
	900	92.4	93.6	78.8	91.7	93.0	79.3
400	1800	95.4	96.2	90.1	93.4	94	88.4
	1200	96.3	96.7	86.5	95.2	95.5	80.3
	900	96.3	96.5	77.5	95.2	95.4	72.7
<u>NOTES:</u> (1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating. (2) Correct to 95 percent power factor and submit capacitor size in KVAR as specified in Article titled "Submittals." (3) Totally enclosed fan cooled efficiencies apply to both horizontal and vertical motors.							

END OF SECTION

SECTION 16262
VARIABLE FREQUENCY DRIVES BELOW 100 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Complete, solid-state variable frequency drive (VFD) unit(s) and VFD system(s) including design, fabrication, software, technical data, spare parts, testing, installation and support requirements for speed control of 3-phase squirrel cage rotor, induction motors, for installation in motor control centers. VFDs shall be ABB ACS550 Series to match existing. VFDs shall be provided as indicated in the Contract Documents.
- B. Related Sections:
 - 1. Section 16000 – Requirements for electrical work.
 - 2. Section 16075 - Electrical Identification.
 - 3. Section 16920 - 600 Volt Motor Control Centers.
 - 4. Section 16155 - Motor Control.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
 - 1. Standard 250 - Enclosures for Electrical Equipment (1,000 volts maximum).
 - 2. NEMA MG1, Part 31 - Motors with higher peak voltage capability.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. Standard 519 - 1992 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
- C. Underwriters' Laboratories (UL):
 - 1. UL label is required.

1.03 SYSTEM DESCRIPTION

- A. The CONTRACTOR and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical required auxiliary devices may include circuit breakers, motor circuit protectors, magnetic starters, solid-state-reduced voltage starter, relays, timers, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment. These auxiliary items may be provided by separate supplier; however, they shall be integrated as complete VFD working system.
- B. See Division 11 and Division 13 for a control description and verify data of the motors and driven equipment including full load current, torque, speed, and performance requirements and provide all supplementary equipment and services to accomplish the necessary operation.

1.04 SUBMITTALS

- A. General Requirements: Submit in accordance with Section 01330, unless otherwise specified in this Article.
- B. Shop Drawings:
 - 1. General non specific "catalog data" are not acceptable.
 - 2. Layout drawings of each VFD in motor control center cabinet or separate enclosure dimensions, access details, weights, arrangement, color, and nameplates, door mounted devices and conduit stub-ups.
 - 3. Internal VFD schematic and interconnection wiring diagrams among internal devices, external devices including terminal blocks, and wire numbering.
 - 4. Specific equipment names, relay and timer coil, respective contact identification numbers shall be consistent with the design Drawings.
 - 5. Complete single line diagrams including, but not limited to, electrical ratings, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system.
 - 6. Complete Bills of Material and catalog data sheets for all equipment and devices.
 - 7. Complete drawings to provide the OWNER with operations and maintenance capabilities.
- C. Product Data:
 - 1. Functional diagrams that identify major system functional blocks and interfaces.
 - 2. Special requirements or restrictions of the motor-load combination that may result from operation on the VFD.
- D. Field Harmonic Test Report (Required if total VDF hp exceeds 100 hp per MCC):
 - 1. Report of harmonic test to verify compliance with limits of harmonic distortion present in the voltage and current waveforms on the electrical distribution system(s) caused by the VFD system(s) as specified in Article "Harmonic Suppression."
- E. Test Reports:
 - 1. Submit certified copies of field test reports verifying adequate performance.
 - 2. Submit factory standard bench-test data verifying that the manufacturer's proposed equipment has been tested after product assembly.
- F. Operation, Maintenance and Installation Instructions: Furnish with the equipment at delivery four (5) copies each of manufacturer's operating and maintenance manuals, installation instructions, and other documentation necessary for the installation, start-up, operation and maintenance of the system.
- G. Guides and Manuals: If the variable frequency drive systems require settings or configuration, provide copies of all settings.

- H. Record Drawings:
 - 1. Drawings of each VFD type representing the as-built condition of the equipment and respective settings. Final or corrected as-built drawing shall be delivered 4 weeks after field system acceptance.
- I. Operation and Maintenance Data.
- J. Warranty documents.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Variable frequency drive manufacturer shall maintain, as part of a national network, engineering service facilities within 150 miles of the equipment installation to provide quick responsive start-up service, training of customer personnel, periodic maintenance service contracts, and emergency troubleshooting and repair service.
 - 2. The manufacturer shall have produced the specified type of VFDs for a minimum period of five (5) years.

1.06 WARRANTY

- A. Contractor and manufacturer shall warrant that the material and workmanship of all components, and the operation of the VFD system shall be free of any limitations and deficiencies. Also, the warranty shall include:
 - 1. Replace components found to be faulty and make changes in equipment, substitution arrangement, include system rewiring, rebuilt or additional equipment required, or adjustments necessary during trial operation or subsequent operation of the unit during the warranty period, to meet the equipment or functional requirements of this Specification.
 - 2. Warranty to be in effect for a period of 24 months following final acceptance of the system.

1.07 MAINTENANCE

- A. Spare Parts: As a minimum, provide the following spare parts:
 - 1. One set of all power and control fuses for each variable frequency drive.
 - 2. One complete main control key pad for each type and rated size of VFD.
 - 3. One spare fan for each VFD unit.
 - 4. Two sets of ventilation filters (if applicable in VFD cabinet louvers).
 - 5. Any special dedicated tool for emergency service and troubleshooting.
- B. Field Services: Manufacturer shall describe the field service system available to support the proposed variable frequency drive system. As a minimum describe:

1. Type of technical support available (e.g., system engineering and technician).
2. Location of field service personnel.
3. Field service daily rates in dollars per hour and dollars per day.
4. Guaranteed response times to service requests.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers, No Equal:
 1. ABB ACS550 Series

2.02 GENERAL REQUIREMENTS

- A. Each VFD system shall be rated for the following:
 1. Supply the amperage demand and speed control of motor size(s) scheduled or indicated on the drawings.
 2. Maintain output frequency (setpoint) with a steady state accuracy of 0.5 percent of rated frequency of 60 hertz for a 24 hour period.
 3. Provide smooth, stepless changes in motor speed, acceleration and deceleration over the entire operating speed (revolutions per minute) range.
 4. Automatic current limit feature during startup and provide a "soft start" torque profile for the motor-load combination. Also, it shall limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable and it shall withstand available short circuit currents of the operating environment.
 5. Operate the motor load continuously within the range of 10 percent to 105 percent of rated speed. The minimum and maximum continuous operating speeds shall each be field adjustable setpoints within this speed range. Provide 2 field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies.
 6. VFD shall have linear acceleration capability to ramp up the speed, in revolutions per minute, of the selected minimum to maximum operating speed range in a maximum of 30 seconds. Provide controlled linear deceleration capability. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.
 7. VFD shall be capable of supplying indefinitely 110 percent of the motor nameplate full load current. Also, the unit shall have a one (1) minute overload current rating of 150 percent of the motor nameplate full load current.
- B. The VFD unit overall efficiency shall be a minimum of 95 percent at rated voltage, frequency, and current. This efficiency shall be calculated as follows:

$$Efficiency (\%) = \frac{Power (Load)}{Power (Supply)} \times 100$$

Power (Load) is the total 3-phase power measured at the output terminals of the drive system, including VFD, output filters or transformers. Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line

reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.

- C. The VFD and/or protective relay system shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 1 percent. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.
- D. VFD shall operate continuously without interruption of service or damage to equipment during transient input voltage variations of minus 40 percent for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or over-voltage protection to trip and remove supply voltage from the drive system.

2.03 SYSTEM FEATURES AND CHARACTERISTICS

- A. Each VFD system shall have microprocessor based controls it shall include the following:
 - 1. Input section with (5) percent (%) line reactor and rectifier shall consist of a 6-pulse full wave diode system and direct current link.
 - 2. The inverter shall use insulated gate bipolar transistors (IGBTs) with space vector pulse width modulation (PWM) technology. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-hertz" ratio to operate the induction motor at the desired speed.
- B. VFD output voltage regulation shall be plus or minus 2 percent and carrier frequency shall be field-adjustable.
- C. Controls and indicators to accomplish operation functions shall be located on the VFD (and if applicable bypass starter equipment assembly) as specified herein and supplemented on the Drawings. As a minimum, the required controls and indicators shall consist of the following features via the keypad or auxiliary devices:
 - 1. Digital Output Speed Indicator: Revolutions per minute.
 - 2. Variable Frequency Drive Mode Indicator: ON-OFF-TEST.
 - 3. Input Voltage: Analog.
 - 4. Output Voltage: Analog.
 - 5. Output Current: Analog.
 - 6. Output Frequency: Analog.
 - 7. Drive Ready Indicator.
 - 8. Running time meter.
 - 9. Control Mode Selector Switches: As required per contract Drawings.
 - 10. Mushroom Head Emergency Stop Pushbutton: On the VFD cabinet
 - 11. Manual speed control and HAND-OFF-AUTO selector switch.
 - 12. Motor winding overtemperature and moisture shutdown indication (if applicable).
 - 13. Alarm Read-out: Display on keypad.
 - 14. Alarm reset button.
 - 15. Alarm, Auxiliary Contacts and Other Devices: as indicated on the Drawings.
 - 16. Molded case circuit breaker disconnect with lockout mechanism

17. An RS485 communication port for future link to a central computer.
- D. VFD system shall provide a 4-20 milliamperes direct current output signal that is proportional to the drive output frequency for use as speed feedback or control and remote speed indication.
- E. VFD system shall accept a 4-20 milliamperes direct current input command signal to control the output frequency in the automatic and/or manual control modes. The controls shall accept the input increase/decrease command with a resolution that permits incremental changes in speed, revolutions per minute, equal to or less than 0.1 percent of rated speed.
- F. When operating in the automatic mode, the VFD system shall shut down during a power outage. Upon restoration of normal power and after an adjustable time delay (0-2 minutes; motor has coasted to zero speed and there is no backspin), the VFD system shall automatically restart and then ramp up to speed as required by the control system. The process operator shall not be required to reset the system manually after a shutdown caused by a power outage.
- G. Furnish door mounted selector switch or keypad pilot device for selection of local/remote speed reference signal (e.g., analog output from a programmable logic controller) supplied to the VFD.
- H. Include in each variable frequency drive system an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall trip and indicate the fault only upon the following conditions:
1. Motor overload.
 2. Motor stator winding fault (phase-to-ground, phase-to-phase).
 3. Loss of input power to the variable frequency drive or unacceptable voltage variation.
 4. High variable frequency drive equipment temperature.
- I. VFD shall include on-line diagnostics with an automatic self-check feature, that will detect a failure which in turn affects motor operation and generates an alarm output, contact rated for 125 volts-direct current.
1. Diagnostics shall operate a visual and audible alarm indicator(s) on the VFD cabinets without opening cabinet doors.
 2. Diagnostics shall provide an easily readable output that will indicate a failure.

2.04 OPERATING CONDITIONS

- A. The following operating conditions are applicable for all VFD equipment.
1. Humidity: 0-95 percent. Space heaters shall be provided to prevent condensation.
 2. Ambient Temperature: minus 20 degrees Celsius to plus 40 degrees Celsius.
 3. Altitude: 100 feet above sea level.
 4. Utility Power Supply: 480 volts, 3-phase, fixed frequency of 60 hertz.
 5. Suitable to operate, at times, on a limited power source with waveform distortion engine-generator set.
 6. Short Circuit Fault Withstand: 65,000 amperes symmetrical at rated voltage.

7. Short Circuit Fault Values for Harmonic Study: actual fault current (as determined by the CONTRACTOR's short circuit study and as accepted by the ENGINEER).

2.05 ENCLOSURES

- A. Unless otherwise specified or indicated on the Drawings, each VFD system enclosure shall be part of the motor control center, in NEMA 1 gasketed force ventilated dead-front with front accessibility, and maximum dimensions per equipment layout on drawings. For outdoor locations, auxiliary enclosure shall be NEMA 4X 316 stainless steel. Design enclosures for top entry of power supply cables and bottom exit of motor cables. Design VFD system so that rear cabinet access is not required for operations, maintenance, and repair tasks.
 1. Treat metal surfaces and structural parts by phosphatizing, or equal, prior to painting.
 2. Apply a gun-metal gray undercoat to enclosures which is equal to zinc chromate.
 3. Finish exterior of the enclosures in ANSI-61 gray enamel.
 4. Brace each door to prevent sag when fully open.
 5. Nameplate indicating equipment name and circuit designation.
- B. Main disconnecting means shall have external operating handle interlocked with the door so that it cannot be opened unless the disconnect is in the OFF position. Power supply to the motor from the VFD shall be capable of being positively locked out in the OFF position. The disconnect shall be interlocked so that equipment cannot be energized when the door is open.
- C. Electrical ground bus shall be tin-plated copper. Power and control wiring shall be copper, and identified in accordance with Section 16075.
- D. Equipment to be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install device assemblies so that a single failed item can be individually removed and replaced.

2.06 SOURCE QUALITY CONTROL

- A. Factory Wiring Labels:
 1. Provide all VFD internal wiring with identification numbers or labels and connected to terminal blocks:
- B. Factory Testing:
 1. Factory test each VFD system in accordance with IEEE and NEMA standards for operational integrity.
 2. VFD system components, including power transistors, GTOs, SCRs, and diodes shall be 100 percent inspected, including temperature cycling and ambient high temperature of 65 degrees Celsius load testing. All integrated circuits shall be inspected, pass/fail tested, temperature cycled and ambient high temperature tested. Small components, including small signal semiconductors, resistors, capacitors, diodes, etc. shall be lot sampled and tested for functionality.
 3. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100 percent redundant. A new and

unused spare replacement fan(s), shipped in original carton, may be acceptable.

4. Authorized representatives of the OWNER shall be allowed free access to the shops at all times while work is in progress for the purpose of inspection, and obtaining information on the progress of the work.
5. VFD system shall not be shipped from the manufacturing and assembly facility until the acceptance tests are completed and the results approved by the test representative.
6. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the CONTRACTOR of responsibilities.

PART 3 EXECUTION

3.01 GENERAL

- A. Variable frequency drives rated below 75 hp shall be installed in motor control centers or in auxiliary enclosures in accordance with Drawings.
- B. Comply with the seismic requirements of the International Building Codes and others as specified in 16000. Design mechanical and electrical equipment, and their supports and connections, to prevent sliding or overturning. Brackets and anchors shall be of ductile material so that they can absorb energy and continue to carry load.
- C. Motor overtemperature protection and motor winding moisture detection devices furnished by pump/motor manufacturer shall be installed and wired in VFD cabinet. Provide any necessary power supply for the proper operation of motor protective devices.

3.02 FIELD QUALITY CONTROL

- A. The CONTRACTOR shall successfully complete Acceptance Test Procedures on the assembled drive system. The test plan shall be submitted for acceptance at least 30 days prior to the planned test date.
- B. Provide the services of an experienced, factory trained technician or service engineer of the variable frequency drive manufacturer, for minimum of 2 days for each VFD unit test and startup, beginning at a date mutually agreeable to the CONTRACTOR and the OWNER. The technician shall be on duty at the site for at least 6 hours per each required day of each VFD normal test and startup; and he shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.
- C. Include in the bid an allowance for factory-trained service personnel, other than sales representatives, to supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested by the CONTRACTOR and the results of these tests have been accepted by the ENGINEER.

- D. Include in the bid the training of personnel in the operation and maintenance of each furnished variable frequency drive pump control system. Training shall include 2 separate days - 4 hour sessions for 5 designated plant operators, plus 2 separate days - 4 hour sessions for 5 designated plant maintenance staff.

END OF SECTION

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SECTION 16720 FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Scope of Work:

1. The Contractor shall have a single Fire Alarm System Supplier (FASS) shall furnish all materials, equipment, labor and services required to achieve a fully integrated and operational Fire Alarm System which shall be in complete compliance with the NFPA Class and Style as specified herein. The Fire Alarm System shall be an analog addressable type system.
2. The FASS shall complete the conceptual design as detailed on the Drawings in full compliance with applicable sections of the NFPA 72, NFPA 70, NFPA 79, Americans with Disabilities Act, and Marin Fire Department requirements. The Drawings and Specifications are not intended to be a complete listing of all components required for the system. Location and type of area smoke detectors as shown on Drawings are approximate only. The FASS shall locate and provide the applicable smoke sensor type as required by the physical environment of the area and the NFPA. All auxiliary and accessory equipment necessary for system performance in compliance with the applicable codes shall be provided even if not specifically detailed on the Drawings or in this Specification. Preparation and submittal of detailed, project specific installation drawings (including but not necessarily limited to mounting, interconnection, wiring type details, supportive calculations, etc.) shall be included as part of this work. This includes preparation of drawings and information, submittal, discussions, testing, repairs, and retests, and coordination needed to secure permits from the Marin Fire Department.
3. The FASS shall coordinate the Fire Alarm System with other related equipment and materials furnished by other suppliers under other sections of these Specifications.
4. The FASS shall ensure that all equipment of the system is furnished, installed and connected in accordance with the manufacturer's instructions.
5. The fire alarm system shall consist of the following major components: Fire Alarm Control Panels (FACP), Fire Alarm Annunciator Panel (FAAP), alarm initiating devices (including manual fire pull stations, automatic smoke detectors, etc.) alarm indicating appliances (including audio alarm devices, visual alarm devices, etc.), fire alarm system standby battery(ies) with charger(s), and communication interface modules as required to interface with equipment furnished under other sections of this Specification.
6. The FASS shall coordinate and install duct smoke detectors where required by Mechanical Code or as indicated on the Drawings.

B. Related Sections:

1. Section 01300 - Submittal.
2. Section 01650 - Facility Start-Up.
3. Section 01700 – Contract Close-out.
4. Section 01730 - Operating and Maintenance Data
5. Section 16000 - Electrical Requirements.
6. Section 16000 – For Training.
7. Section 16123 – For 600 Volt or Less Wires and Cables.

- C. This section contains requirements for submittal information that must be stamped and signed by a professional engineer. See SUBMITTALS for requirements.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. NFPA 72 - National Fire Alarm Code.
- C. Uniform Building Code.
- D. Uniform Fire Code.

1.3 SYSTEM DESCRIPTION

- A. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system with connections to plant programmable logic controller system (PLC).
- B. CONTRACTOR shall be responsible for obtaining Authority Having Jurisdiction approval stamp upon shop drawings. Contractor shall be responsible for coordinating inspections of Fire Alarm Control Panel and all devices including smoke detectors, emergency alarms, fire alarms by Authority Having Jurisdiction.

1.4 SUBMITTALS

- A. Shop Drawings: Provide complete bill of materials and system layout and point-to-point wiring diagram showing each device, wire size/type and wiring connection required. CAD drawing of the building may be available for the Contractor's use upon request.
- B. Product Data: Provide electrical characteristics, connection requirements, and operation details of all equipment.
- C. Project specific installation details including mounting heights and locations.

- D. Complete conduit interconnection diagrams (conduit riser diagrams) including proposed routing and labeling of all conduits for the system.
- E. Test Reports: Indicate satisfactory completion of required tests and inspections.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.
- G. Following acceptance by the ENGINEER, CONTRACTOR shall submit plans for approval by the Authority Having Jurisdiction (AHJ). Verification of AHJ approval shall be submitted to the ENGINEER.
- H. Submit hard copies of fire alarm system I/O point list.
- I. Submit copies of approved applications.
- J. Provide copy of MFACP, FACP's programming software, on CD, for use by plant staff.
- K. Spare parts list for extra materials being furnished.
- L. As specified in Section 01730.
- M. Submittal shall be in 3-ring binders with full size drawings neatly folded in plastic 8 ½ by 11 plastic cover for each drawings.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of initiating devices, signaling appliances, and end-of-line devices. Record final wiring.

1.6 OPERATION AND MAINTENANCE DATA

- A. O&M manuals: Submit in accordance with Section 01730.
- B. Operation Data: Operating instructions.
- C. Maintenance Data: Maintenance and repair procedures.

1.7 QUALITY ASSURANCE

- A. The Fire Alarm System Supplier (FASS) shall be a "specialty contractor" or a manufacturer regularly engaged in the design and the installation of fire alarm systems and their related subsystems. For the purposes of this Specification Section, a "specialty contractor" shall be interpreted to mean an organization that complies with all of the following criteria:
 - 1. Employs a registered professional engineer or a registered fire protection engineer to supervise or perform the work required by this Specification section.

2. Employs personnel on this project who have successfully completed NFPA or manufacturer's training courses on general fire protection principles and practices.
 3. Has performed work (including design, installation, startup, testing and maintenance) of similar or greater complexity on at least five previous projects.
 4. Has been actively engaged in the type of work specified in this Specification Section for a minimum of five years.
- B. For the purposes of this Specification Section, a "manufacturer" shall be interpreted to mean an organization that complies with all of the following criteria:
1. Manufacturers at least 75 percent (as measured by equipment cost) of the hardware specified in this section and which is furnished for this project.
 2. Complies with the preceding criteria established for a "specialty contractor."
- C. The FASS shall maintain a permanent, fully staffed and equipped service facility within 100 miles of the project site. The service facility shall have full-time employees qualified in the design, installation, testing and servicing of the equipment and systems specified in this section.
- D. Actual installation of the fire alarm system need not be performed by the FASS's employees; however, the FASS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the system. NICET level 2 technician certification is required for wiring terminations.
- E. Being listed in this specification section does not relieve any potential FASS from meeting the qualifications specified in this Section.
- F. Each and all items of the fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the corresponding "U.L." label.
- G. All materials shall be listed by UL, NPFA, and the State Fire Marshal wherever standards have been established by those organizations. Listing date shall be current.
- H. When more restrictive requirements have been adopted by the local authority having jurisdiction, the system shall comply with the local requirements.
- I. Manufacturer's model numbers are included to provide an indication of the basic system component and features; however, the equipment furnished shall be inclusive of all requirements of the written text to the extent that the text specifies optional or additional features not included with the basic model number.

1.8 FIELD ACCEPTANCE TEST BINDER

- A. A system field acceptance test binder shall be prepared by the fire alarm system supplier and submitted to the ENGINEER for approval. The purpose of this binder is to consolidate and organize the testing requirements and results for all components in the system.
- B. A test summary tabulation shall be provided for each switch or control function in the project organized by room/area number. The tabulation shall include the following as a minimum:
 - 1. Room/area number with a separate line for each device or control function.
 - 2. Physical installation check-off box for each device and function.
 - 3. Functional check-off box for each device and function.
 - 4. Full acceptance check-off box for each device and function.
 - 5. Comments box for each device switch and function.

1.9 FINAL DOCUMENTATION

- A. The fire alarm system supplier shall submit the following final documentation prior to final acceptance of the system:
 - 1. As-built documentation of the Fire Alarm System.
 - 2. Hardware Maintenance Documentation.
- B. The final documentation shall be new documentation written specifically for this Work, but may include standard and modified standard documentation. See Section 01730 for additional requirements. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.
- C. The documentation shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operation, and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained shall apply specifically to the equipment furnished and shall only include instruction that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference document.
- D. The requirements for the final documentation are as follows:
 - 1. As-built documentation shall include all previous submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Field Acceptance Tests shall be incorporated in this documentation. As-built Drawing documentation shall include as a minimum; the following information:
 - a. Field wiring color code and identification tag.

- b. Field wiring termination points.
 - c. Spare wire and control points.
- 2. The Hardware Maintenance Documentation shall describe the detailed preventive and corrective procedures required to keep the Fire Alarm System in good operating condition. A maintenance manual shall be furnished for all delivered hardware. The Hardware Maintenance Documentation shall include, as a minimum the following information:
 - a. Operation Information - This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the system.
 - b. Preventive-maintenance Instruction - These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the system.
 - c. Corrective-maintenance Instruction - These instructions shall include guides for locating malfunctions. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable sources(s) of trouble, the systems, probable cause, and instructions for remedying the malfunction.
 - d. Parts Information - This information shall include the identification of each replaceable or field-repairable module. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part.

1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance of fire alarm system for one year from Date of Substantial Completion.

1.11 EXTRA MATERIALS

- A. Provide 3 keys of each type including manual pull station reset key.
- B. Provide 2 of each type of automatic smoke detector without base.
- C. Provide 1 of each type of fire alarm system addressable module used.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. One of the following or equal:
 - 1. Simplex Time Recorder Company.
 - 2. Honeywell, Incorporated.
 - 3. Notifier.

4. Siemens.

2.2 FIRE ALARM CONTROL PANELS

The FACP's shall have the following characteristics:

- A. Model: Simplex 4020 series, Siemens Desigo Series, or equal.
- B. Control Panel: Modular construction with surface mounted enclosure.
- C. Power supply: 120 VAC input, 24VDC, 5A output, to serve control panel modules, remote detectors, remote annunciators, relays, and alarm signaling devices. Include battery-operated emergency power supply with capacity for operating system in standby mode for 10 hours followed by alarm mode for 10 minutes.
- D. System Supervision: Component or power supply failure places system in trouble mode.
- E. Initiating Device Circuits: Supervised zone module with alarm and trouble indication; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from initiating an alarm.
- F. Indicating Appliance Circuits: Supervised signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from signaling an alarm.
- G. Remote Station Signal Transmitter: Electrically supervised digital alarm communicator transmitter.
- H. Auxiliary Relays: Provide sufficient SPDT auxiliary relay contacts to provide accessory functions specified.
- I. Provide ACKNOWLEDGE, SILENCE, EVACUATE, RESET switch controls.
- J. Trouble Sequence of Operation: System or circuit trouble places system in trouble mode, which causes the following system operations:
 1. Visual and audible trouble alarm indicated at fire alarm control panel.
 2. Visual and audible trouble alarm indicated at remote annunciator panel.
 3. Trouble signal transmitted to central station.
 4. Manual acknowledge function at fire alarm control panel silences audible trouble alarm; visual alarm is displayed until initiating failure or circuit trouble is cleared.
 5. Transmit signal to plant control system.
- K. Alarm Sequence of Operation: Actuation of initiating device places circuit in alarm mode, which causes the following system operations:

1. Sound and display local fire alarm signaling devices.
 2. Indicate location of alarm zone on fire alarm control panel and on remote annunciator panel.
 3. Transmit signal by zone to building smoke removal system if any.
 4. Transmit signal to building mechanical systems to initiate shutdown of fans and damper operation.
 5. Transmit signal to plant control system.
- L. Alarm Reset: System remains in alarm mode until manually reset with key-accessible reset function; system resets only if initiating circuits are out of alarm mode.
- M. Lamp Test: Manual lamp test function causes alarm indication at each zone at fire alarm control panel and at annunciator panel.
- N. Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.
- O. Zoning: Provide I/O modules required for zoning based on drawings. The limit for any loop is any combination of 20 signaling line circuits, notification appliance circuits, and relay contact outputs.
- P. The system data highway for the communications between the MFACP to each FACP shall be class A type as shown on the Drawings.
- Q. Each fire alarm control panel shall have a dry contact for fire alarm and a dry contact for trouble alarm signals in addition to a communication port. The FACP shall have a second communication port to transmit the following signals to the Plant PLC System:
1. Headworks MCC Room- Fire Alarm
 2. Headworks MCC Room- Trouble Alarm

2.3 FIRE ALARM DEVICES

- A. Manual Station: Semi-Flush mounted, addressable dual action manual station with keyed reset.
- B. Ceiling Mounted Smoke Detector: photoelectric type fixed sensitivity, addressable, plug-in base, and visual indication of detector actuation, suitable for mounting on 4-inch (102 mm) outlet box. Provide mounting base.

2.4 SIGNALING APPLIANCES

- A. Alarm Horn/Strobe: Fire alarm horn. Sound rating 101 peak dB at 10 feet, UL listed 464. Provide integral strobe lamp and flasher, ADA compliant. Rated 24vdc, 75 candela. UL listed 1971. Lettered "FIRE" on face of device.

2.5 AUXILIARY DEVICES

- A. UDACT module: Digital Alarm Communicator/Transmitter.
 - 1. Provide with RJ-45 connections, or ST connections for future use.

2.6 FIRE ALARM WIRE, CABLE, AND CONDUIT

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Section 16000.
- B. Initiating Device Addressable Circuit (SLC): For areas not used for air handling; power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated 105 C., degrees, single twisted pair, shielded, #16 AWG. West Penn #975 or Belden #9575. For areas used for air handling provide similar cable that is plenum rated, West Penn #25-975.
- C. Initiating Device Circuit and Indicating Appliance Circuits: For areas not used for air handling; power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated 105 degrees C, single twisted pair. Belden #9572, where installed in areas used for air handling; power limited fire-protective signaling cable classified for fire and smoke characteristics, copper conductor, 300 volts insulation rated 105 degrees C, suitable for use in air handling ducts, hollow spaces used as ducts, and plenums.
- D. The FASS shall be responsible for specifying the exact type, quantity, size, and location of all conduit, cable, and wire for the fire alarm system. Note that some details are shown on the physical drawings for clarity in communicating interlocking or interconnection requirements. Regardless of any details shown, the FASS is responsible for specifying the complete wire/cable/conduit installation as described above.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions. Program FACP to annunciate proper alarm signals as well as trouble alarm signals.
- B. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit.
- C. Automatic Detector Installation: Conform to NFPA 72.
- D. Conduit and wire requirements are, in general, not shown on the Drawings. The system shall be wired in conduit throughout (except where noted as internal wirings for clarity) in accordance with the manufacturer's diagrams and requirements, the system riser diagram shown on the Drawings, the remainder of Division 16 specifications, and submittal data.
- E. Final connections in the fire alarm system shall be made by or under the direct supervision of an authorized representative of the FASS Upon completion of the

installation and testing as specified herein, the FASS shall check and test the entire system with the presence of the Engineer and the District.

- F. All components shall be mounted at spacings and heights as detailed in NFPS 72 and ADA.

3.2 MANUFACTURER'S SERVICE DURING INSTALLATION

- A. Supervision: Check and certify the installation of all components before power is applied.
- B. Check Out: Place the equipment into operation and making necessary adjustments.
- C. Instruction: Provide instruction of plant personnel in the operation and maintenance of all equipment of the system.

3.3 CORRECTION OF DEFICIENCIES

- A. All deficiencies in work and/or items not meeting specified testing requirements shall be corrected in order to meeting specification requirements at no additional cost.

3.4 TESTS

- A. The approved Field Acceptance Test Binder shall form the basis of the documentation of the system acceptance tests. All acceptance tests shall be witnessed by and signed off by the Engineer, the FASS's Field Engineer, the installing Contractor, and a representative of the District, and any special tools, equipment and labor to perform the tests.
- B. The ENGINEER and the DISTRICT shall be notified in writing a minimum of two weeks prior to the scheduled day for the field acceptance tests.
- C. Each device and control function shall be individually witness tested and recorded in the Field Acceptance Test Binder. Two certified copies of the tests shall be furnished.

3.5 TRAINING

- A. Provide operations and maintenance training, including both classroom and hands-on training of the Fire Alarm System in accordance with Section 16000.

END OF SECTION

SECTION 16860
INSTALLATION OF PACKAGED EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes installation of packaged equipment as described in Section 01010 "Summary of Work". Contractor shall provide all required labor and materials in complete installation and testing of packaged equipment, identified on the drawings and specified in Div 11, which consists of the following but not limited to:

1. Filter Equipment
2. Barscreen Equipment
3. Grit Washer Equipment

Electrical drawings may not show all of the required components of the above equipment due to space limitation. In addition, Contractor shall note that the drawings show packaged equipment with accessories and components from one vendor/manufacture which may not necessarily be the one supplied by the Contractor. Contractor shall refer to all mechanical drawings and specs for the approximate location for each component of the equipment requiring power and or control. Contractor shall also note that there are many loose components of the packaged equipment. They shall be installed and wired individually as required by the packaged equipment manufacturers as per the approved shop drawings.

- B. Related sections:

1. All sections in Division 15 Mechanical
2. All sections in Division 16 Electrical
3. Section 01300 – Submittal
4. Section 01650 – Facility Start-up
5. Section 01700 – Contract Close-out
6. Section 01730 – O&M Manual Data
7. Section 16000 – For Seismic Design Criteria

1.2 QUALITY ASSURANCE

- A. Conform to and comply with NFPA 70.
- B. All materials and equipment installed under this section shall be listed and labeled by a nationally recognized testing laboratory (NRTL) recognized under 29 CFR 1910.7, for the purpose specified and indicated.

1.3 STORAGE AND HANDLING

- A. Receive UV equipment, Control panel CP-1, Power Distribution Centers and various rack mounted control panels and field instruments, valves etc. from the UV equipment supplier.
- B. Store and protect equipment under provisions of section 01600- Delivery, Storage and Handling.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle all of the equipment in accordance with manufacturer's written instructions. Lift only with lugs provided for that purpose. Handle carefully to avoid damage to equipment, components, enclosure, and finish.

PART 2 PRODUCT

Not Used.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, wire, check and test packaged equipment in accordance with contract Drawings and Mechanical Equipment Supplier's installation approved drawings and instructions. The equipment shall be leveled and anchored directly to equipment concrete pad or floor as shown on the Drawings. Grout and caulk all voids beneath the equipment base. All wirings shall be in conduits.
- B. Remove all temporary lifting angles, lugs and shipping braces and materials.
- C. Make wiring interconnections between shipping splits.
- D. Install bus splice plates and torque connections.
- E. Seal all seams, cracks, or openings in outdoor enclosure. Touch up damaged paint finishes.
- F. Provide and install power, control and instrumentation wirings and connect and terminate these conductors in accordance with the packaged equipment manufacturer's approved shop drawings and as required by these Contract Drawings.
- G. Where conduit size is not shown on the drawings, size the conduit per NEC and shall not be smaller than 3/4" for power circuits and instrument circuits. Raceways for power and instruments shall be separate. Raceways for local data highways or data link shall also be separate.

- H. Cable trays may be used with multi-conductor cables for up to #1 AWG for ONLY power and control circuits. The tray shall be used for up to 50% max available space, the remainder 50% spacing shall be reserved for future use.
- I. Follow Engineer-approved mechanical equipment drawings to connect each and every instrument and device as well as motorized equipment shown in these drawings. Provide and install all cables and conduits listed on these drawings.
- J. For future equipment, provide spare empty conduits from the location shown on the drawings to the conduit system for future use. Tag spare conduits as per Section 16000.

3.2 IDENTIFICATION

- A. Refer to section 16000 - Requirements for electrical work for identification requirements.
- B. Provide neatly typed label inside each enclosure door identifying motors served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- C. As-builts shall be provided on inside door in plastic cover.

3.3 FIELD QUALITY CONTROL

Refer to section 16940 "Electrical Testing" for required field tests. Provide assistance to manufacturer's field service start-up personnel during preliminary and final functional testing of all packaged equipment. This service shall include three full-time field staff for minimum of four weeks. Coordinate testing schedule with the City.

3.4 CLEANING

Remove all rubbish and debris from inside and around equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean rags. Do not use compressed air.

END OF SECTION

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SECTION 16920
600 VOLT MOTOR CONTROL CENTERS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Scope: This section specifies freestanding, factory assembled 600 volt motor control center section (MCC).
- B. Equipment List: MCCs and accessories specified herein shall be manufactured by Eaton Cutler-Hammer, Allen-Bradley, General Electric, Square D or equal.

1.2 RELATED SECTIONS

- A. Section 16000 – Requirements for Electrical Work.

1.3 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NEMA ICS 1-88	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2-88	Industrial Control Devices, Controllers and Assemblies
JIC EMP 1-67	Electrical Standards for Mass Production Equipment
UL 845-88	Motor Control Centers

1.4 SUBMITTALS

- A. The following specific submittal requirements for the MCC's shall be followed:
 - 1. Contractor shall formally place an order with MCC manufacturer within sixty days or sooner of the award of the contract. The order shall include all relevant drawings and specs including any addendum items associated with the equipment.
 - 2. Contractor shall submit shop drawings to the District within 6 weeks of the order being placed.
 - 3. Contractor shall forward review comments to MCC manufacturer within two days after receipt of the comments by the District.

4. Contractor shall provide the release for manufacturing to MCC manufacturer within 3 business days of receiving a favorably reviewed submittal and shall provide the District with the shipping date.
 5. Prior to shipment, a factory test of the equipment optionally witnessed by the District shall occur. Factory test shall include operations of power and control components, interface with SCADA, PLC and related interlocks as per design documents.
- B. The following information contain in three-ring binder shall be provided and submitted in accordance with Section 16000:
1. Elementary connection, single-line diagram, individual equipment control schematic diagrams, and interconnection diagrams as required in accordance with JIC EMP 1 and/or NEMA ICS standards. Each and every terminal shall be identified with terminal number. Remote mounted pilot devices shall also be identified on wiring diagram.
 2. List of starters and feeder tap compartments indicating the size and type of circuit protection. Nameplate schedule for each equipment compartment door shall also be submitted.
 3. Interrupting withstand and continuous current rating of:
 - a. Bus bars
 - b. Feeder tap units
 - c. Starter units
 - d. Main incoming units
 4. A copy of this specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

PART 2 PRODUCTS

2.1 ACCEPTABLE PRODUCTS

- A. Motor control centers shall comply with ANSI/NEMA ICS 2-322, AC General-Purpose Motor Control Centers, and UL 845 and shall be Cutler-Hammer, General Electric, Square D, Allen-Bradley, or equal.

2.2 METERING REQUIREMENTS

- A. Motor control centers shall be rated 600 volts, 60 hertz, 3 phase, 3-wire was specified and shall be suitable for operation at the specified voltages and short circuit capacities. Each MCC shall be provided with an electronic multi-function meter which shall display electric parameters such as voltage, current, KW, KWHR, power factor, KVAR, frequency, harmonics (voltage and current). Provide required industrial, high accuracy type PTs and CTs for all metering. Proper fuses shall be provided for each metering and relay devices. Meter shall have RS-232/485/422 and one TCP/IP ETHERNET communication port for connection to the District 's existing SCADA system. A power monitor relay shall also be provided to protect the MCC against power system

disturbances such as current unbalance, voltage unbalance, under and over voltage, phase loss, phase reversal. The power monitor relay shall have both manual and automatic reset functions and adjustable time delay with two N.O and two N.C dry contacts 5A rated. Main breaker shall be provided with a 120VAC shunt trip.

2.3 STRUCTURE AND CONSTRUCTION

A. Structure:

1. The motor control center new section shall be made of No. 14 gauge steel minimum and each section shall be 90 inches high by 20 inches wide by 21 inches deep or as indicated on the Drawings. The individual unit compartments shall be a minimum of 12 inches high. There shall be 72 inches available for stacking starter units. Compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.
2. A full height vertical wireway, 20 square inch minimum, shall be provided for each vertical motor control center section. The wireway shall contain full height removable doors. Horizontal wireways shall be provided top and bottom, extending the length of motor control centers.
3. Bottom channel sills to be welded shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup. A removable lifting angle shall be mounted on top and shall extend the width of the motor control center lineup.

B. CONSTRUCTION:

1. The motor control center section shall have NEMA 1, gasketed enclosures.
2. Starter units, size 4 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, plated copper free-floating stabs, steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed. Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.
3. Circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.

2.4 SEISMIC REQUIREMENT

MCC shall have provisions for being tied down to resist seismic forces as per latest California Building Code requirements. Provide certification from the MCC manufacturer that the MCC meets and exceeds seismic requirements for the project location in the San Francisco Bay Area.

2.5 FINISH AND COLOR

- ### A.
- The MCC shall be ANSI 70 gray finish.

2.6 BUS

A. General:

1. Bus shall be tin-plated copper with bolted connections between vertical and horizontal bus bars. Access for tightening these connections shall be from the front, without the need for tools on the rear of the connection. Insulated horizontal and vertical bus barriers shall be provided. Barriers shall be fabricated from high-strength, glass-filled polyester resin. Unless otherwise specified, the bus shall be braced to withstand a minimum fault current of 65,000 amperes, RMS, symmetrical.

B. Horizontal bus: Unless otherwise specified, the main horizontal bus shall be rated a minimum 800 amperes continuous.

C. Vertical Bus: Unless otherwise specified, the vertical bus shall be rated a minimum 300 amperes continuous.

D. Neutral Bus: A 100% capacity neutral bus shall be provided. (The neutral bus shall have the same rating as the main horizontal bus.)

E. Ground Bus: A 1/4-inch by 2-inch ground bus shall be provided the full length of the motor control center. Ground bus shall be located at the bottom of the motor control center. Provide a lug to terminate a bare 4/0 AWG copper ground conductors at each end of the ground bus.

2.7 WIRING

A. General: Motor control centers shall be provided with NEMA Class II, Type B wiring. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller. Motor control centers shall be provided with all necessary interconnecting wiring and interlocking. When a relay cubicle is specified on the drawings or schedules, wire directly to the relay sockets of plug-in relays as part of the interconnecting wiring. Provide elementary and connection diagrams for each starter unit and an interconnection diagram for the entire motor control center.

B. Power Wire: Power wire shall be copper 90 degrees C, dry locations, "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded. All power cable terminals shall be color coded with color tapes and shall indicate circuit designation as shown on single-line diagram.

C. Control Wire: Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C and UL listed for panel wiring.

D. Terminations and Cable Connections:

1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.

2. Cable Connectors: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 MCM, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M, Burndy, or equal.

- E. Conductor Markers: Markers used for identification shall meet the requirements of Section 16075 – Electrical Identification.

2.8 MAIN AND FEEDER BRANCH CIRCUIT PROTECTION

- A. General: Feeder tap units shall consist of circuit breakers, as specified.
- B. Feeder Tap Cubicles: Provide dual circuit breaker cubicles to fit breaker arrangements as shown on the Drawings. The cubicles shall be drawout plug-in construction with spring type stabs. The doors shall be hinged with screw type fasteners. The door shall be interlocked to prevent the door from opening when the breakers are on. Provide a nameplate for each breaker compartment.
- C. Circuit Breakers (Thermal Magnetic): Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amps symmetrical at 480V AC. Main breaker of 200 amp or larger shall be provided with solid-state multi function trip units with long time, long time delay, short time, short time delay and ground fault protection. Main breaker for MCC shall be provided with a shunt trip coil and with two auxiliary switches rated for 5A minimum.

2.9 MOTOR STARTER UNITS

- A. General: Motor starter units shall be combination type with contactor motor circuit protector as specified on the drawings. The starter units shall have a minimum combination UL listing of 65,000 amps RMS, symmetrical at 480V AC.
- B. Motor Circuit Protectors: The molded case motor circuit protector shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker. The motor circuit protector shall be set at its lowest position at the factory.
- C. Control Transformers: Each control transformer shall be rated 480/240-120V, single phase, 2 wire, 60 Hz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA starter size	Minimum transformer volt-ampere rating
1	100
2	150

3	200
4	300

1. Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters. Provide an extra 50VA for CPTs of motor control circuit serves motor space heater.
2. Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.

D. Contactors:

1. Unless otherwise specified, contactors shall be full voltage, 3-pole, 600 volt AC, NEMA size 1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools.
2. Reversing, multispeed, and reduced voltage starters shall have additional contactors, overload relays, and auxiliary relays as required, and shall have mechanically interlocked contactor coils to prevent simultaneous engagement.

E. Spare Parts: Provide the following spares with no additional costs to the District:

- a. Two dozens control fuses.
- b. Three 100VA CPTs
- c. Three pushbuttons and three pilot lights of each type.
- d. One gallon of touch up paint.
- e. Two size one starters (open type)

F. Auxiliary Contacts: Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Unless otherwise specified on the drawings, each contactor shall be equipped with two normally open and two normally closed electrically isolated auxiliary contacts. Auxiliary contacts shall be wired out to terminal blocks. Refer to drawings for actual quantities required.

G. Overload Relay: The overload relay with three heater elements shall protect the power wiring and motor from excessive overcurrents. The relay shall be ambient compensated and have adjustment from 90 to 110 percent of the normal heater rating. The sensing element shall be bimetal type and conform to ANSI/NEMA ICS 2-222.06, Class 20 tripping time.

H. Terminal Blocks: Terminal blocks shall be screw type rated 600 volts; 20 amperes for control wiring and 30 amperes power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.10 VARIABLE FREQUENCY DRIVE

- A. The VFD shall be of Pulse Width Modulated (PWM) design suitable for use with standard induction motor. They shall be Eaton (Cutler-Hammer) SVX9000 Series, Allen-Bradley, ABB or equal. For stand-alone VFD systems, see Section 16262. They shall have the following features:
1. VFD shall be rated for 15% extra capacity to drive a standard NEMA design B motor, with 1.15 service factor. For motors rated 600 rpm or less, the VFD shall be rated for 125% of motor's full load current.
 2. VFD shall have the following characteristics in addition to required devices shown on the drawings:
 - a. 480VAC power input (-10% to +10%), constant torque type
 - b. Latest IGBT technology
 - c. Minimum 97% efficiency at full load and maintain minimum 96% power factor.
 - d. Can sustain at least 1 minute of 110% overload
 - e. Meet IEEE Standard 519 regarding harmonic distortion considering the MCC is the PCC defined by IEEE 519.
 - f. 6-pulse type.
 - g. Keypad type control function keys in addition to standard display functions and or devices. Diagnostic, status and alarm display functions.
 - h. Speed and control functions: Minimum speed ramp, maximum speed ramp, PID controller with remote speed follower functions. Speed output (4-20maDC for remote indication). Remote start/stop control functions.
 - i. Alarm and auxiliary contacts rated for minimum 3A at 120VAC:
 - 1) Running
 - 2) Failed or faulted
 - 3) In AUTO
 - j. Protective functions against:
 - 1) Overload, over current or short circuit.
 - 2) Over voltage, under voltage, single-phasing
 - 3) Over frequency.
 - 4) Hi internal temperature.
 - 5) Motor stall
 - 6) Ground fault
 - 7) Microprocessor failure
 - 8) Hi torque
 - k. Input 3% impedance line reactor made by Trans-Coil, Inc. or equal
 - l. Output 3% impedance load reactor made by Trans-Coil Inc. or equal
 - m. RS-232C data communication port (MODBUS)
 - n. EMI filters to reduce electromagnetic noises.
 - o. Manual and Automatic control functions.
 - p. 120 volt control voltage.
 - q. Six programmable digital inputs, two configurable analog inputs, one programmable digital output and one programmable analog output.
 - r. Control pilot devices as shown on the drawings.

2.11 METERING SECTION

- A. Metering section shall be provided with required provisions for PTs and CTs suitable for installation of multi function electronic meter. The service shall be 480V three-phase four-wire.

2.12 MISCELLANEOUS

A. General:

1. Control devices such as pushbuttons, selector switches, indicating lights (push-to-test type) and overload reset pushbuttons shall be mounted on the unit compartment door.
2. The control devices shall comply with the requirements of applicable DIV 16 section.
3. Line reactor (3%) and load reactors (3%) shall be manufactured by Trans-Coil Inc, Mirus International Inc, or equal..
4. Wire motor protection relays provided by the pump manufacturer as part of the control circuitries as shown on the drawings.
5. Main service power protection monitor relay shall be Multilin multi function relay, Eaton equivalent, or equal.
6. Provide a UL 1449 listed surge suppression system of latest MOV type technology. The suppressor shall be of voltage type with thermal fusing. The suppressor shall be capable of withstanding 100,000 amperes per phase and shall be equipped with LED indicator, dry contact for remote alarm and local audible alarm. It shall be Square D SurgeLogic XW series, Cutler Hammer equivalent, or equal suitable for use with 480/277V three phase four wire service. This surge suppression system shall be protected by a 15A or 20A 3P circuit breaker as shown on the Drawings.
7. Panelboards as specified in Section 16000 and Section 16159.
8. Provide an Ethernet switch for connection to the District SCADA system. The switch shall be 6-port minimum, industrial type, 24VDC, din-rail mounted as manufactured by Moxa, Sixnet, or equal.

- B. Provide a permanent pocket on the side of the MCC to hold as-built documents and O&M Manual.

- C. Nameplates: Nameplates shall be provided in accordance with the requirements of paragraph 16075-2.4 Nameplates shall be provided for all cubicles and compartments. A Master nameplate with large lettering (one-inch high) shall be provided identifying name of the motor control center.

2.13 PRODUCT DATA

- A. The following information shall be provided in accordance with Section 01300:

1. Applicable operation and maintenance information as specified in Section 16000.
2. Dimensions and weights.
3. Installation instructions.
4. Manufacturer's product data.

PART 3 EXECUTION

3.1 GENERAL

- A. The motor control center sections shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.
- B. The overload relay heater elements class 20 shall be provided by the Contractor and sized based on the actual full load amperes of the motor connected to the starter. Provide a summary of all overload heaters including the motor nameplate data and corresponding overload heater catalog number and rating as part of as-built drawings for review and approval.
- C. The motor circuit protectors shall be adjusted by the Contractor to the lowest setting not causing false tripping.
- D. Install anchor bolts to hold down MCC as per typical detail shown on the drawing to resist seismic activities. Install anchor bolts to hold down auxiliary enclosure as per the manufacturer's requirements to meet seismic requirements per California Building Code. Caulk around the base of the auxiliary enclosure after installation.
- E. Provide color coded tapes and circuit identification to all power cables and terminals. Refer to Section 16000 for color assignment.

3.2 FIELD TESTS

- A. Motor control centers shall be tested in accordance with Section 16000 and Section 16940. Testing shall include individual starters. Submit final as-built prior to performing final acceptance test. Field test records shall include data such as motor nameplate rating, overload catalog number and rating and actual full load current drawn by the installed equipment.

3.3 TRAINING

- A. Provide training to the DISTRICT's electrical and instrumentation staff. Training shall include one session of four hours which includes one two hours of theory of operations and two hours of hand-on practice. Training shall be performed by the manufacturers' field representatives.

END OF SECTION

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SECTION 16921
POWER QUALITY EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. Where specified and shown on the drawings, power quality equipment shall be furnished and installed. Power quality equipment covered by this section includes line reactors and harmonic filters.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in the Section:

- 1. American National Standards Institute (ANSI):
 - a. C2 – National Electrical Safety Code
- 2. National Electrical Code
- 3. IEEE 519

1.3 SUBMITTALS

- A. Submit Specifications and Drawings on Power Quality Equipment for Engineer's review. Submittals shall include wiring diagrams, dimensions, ratings, weight and installation details.

1.4 PROJECT CONDITIONS

- A. Installation Conditions: Power Quality Equipment shall be located in a new Motor Control Center installed in an electrical room provided with air conditioning system.

PART 2 PRODUCTS

2.1 LINE REACTORS

- A. Line reactors shall be UL-listed, low impedance (3%) or high impedance (5%) as indicated on the drawings and shall be suitable for use with 480V AC power system. They shall be manufactured by TCI, Mirus International Inc., or equal.
- B. The reactors shall be sized in accordance with the motor horsepower or with electrical current rating of the equipment shown on the drawings.
- C. Operating ambient temperature rating of the reactors shall be 40 degrees C

2.2 HARMONIC FILTERS

- A. Harmonic filters shall be active type filters suitable for use with 480VAC power system to mitigate harmonics generated by non-linear loads. They shall be manufactured by Accusine, TCI , or equal.
- B. The filters shall be designed to automatically inject canceling harmonic currents to reduce all harmonics to below 5% TDD and 5% THD as caused by non-linear loads. The units shall be provided with a human machine interface to display its power system parameters such as AC line voltages, total rms load current, harmonic current of loads, reactive current of load, output harmonic and reactive current of the filters. Provide an auxiliary dry contact (NO) for Filter Run, Filter Fault, at maximum capacity status.
- C. Each filter shall have a Modbus TCP/IP (ETHERNET) communication port for interface with existing plant SCADA system.
- D. Operating ambient temperature rating of the filters shall be 40 degrees C

PART 3 EXECUTION

3.1 INSTALLATION

- A. Follow instructions from the manufacturers regarding detailed installation.
- B. Protect equipment until acceptance by the District.
- C. Check entire system and record functions of the equipment with and without the equipment being on-line and submit field report to the Engineer for final review and acceptance.

3.2 FIELD STARTUP AND TESTING

- A. Provide one day of service from a factory-trained technician to provide startup and testing during final functional system tests.
- B. Training shall also be provided while the factory technician is on site. Training shall include one session of four hours for plant electrical and instrumentation staff.

END OF SECTION

**SECTION 16938
POWER SYSTEM STUDY**

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall prepare a short circuit (SC), and protective device evaluation/coordination (PDEC) and arc flash study for the electrical power system in accordance with the requirements of these Specifications and as shown.
- B. The study shall include all portions of the electrical distribution system from the utility service for utility 480V power sources and standby power sources down to and including the 240V panelboards. This shall include all existing and new electrical equipment as shown on the single-line diagrams.
- C. It is the responsibility of the Contractor to obtain the information required for the study from PG&E, the equipment manufacturers and suppliers. The equipment characteristics and data in the study shall match the equipment and associated impedance actually being installed. Copy of the previous study done by a consultant will be available as a reference although the Contractor shall be responsible for field verifying the accuracy and data of the previous study.
- D. The Contractor shall expedite and be fully responsible for collection of data from equipment suppliers, from PG&E to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.

1.2 ORGANIZATION'S QUALIFICATIONS

- A. Short circuit studies, protective device evaluation studies, and protective device coordination studies shall be performed by a professional electrical engineer from the low voltage switchgear manufacturer who has been regularly engaged in short circuit and protective device coordination services for a period of at least 10 years. The study shall utilize proven computer programs for making three-phase fault duty and single phase ground fault duty calculations. The studies shall be signed and stamped by a professional electrical engineer, registered in the State of California, responsible for the studies. It is strongly preferred by the Engineer that the study be performed by Engineering Services offered by the manufacturer of the new electrical distribution (MCC) equipment. Submit resume showing qualification of the Engineer who will personally supervise and sign the studies for review and approval. Three recent projects with references, phones and names shall be provided for verification.
- B. The studies shall be performed by Emerson Electrical Reliability Services, General Electric Engineering Services, Square D Engineering Services, or Eaton Electrical Services.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The short circuit and protective device coordination study shall be conducted under the applicable standards of the American National Standards Institute (ANSI), and the latest edition of the National Electrical Code (NEC). Specifically, the following standards shall apply.

ANSI/IEEE 141 - Recommended Practice for Electrical Power Distribution for Industrial Plants

ANSI/IEEE 242 - Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems

ANSI/IEEE C 37.010 - Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

ANSI/IEEE C 37.13 - Low-Voltage AC Power Circuit Breakers Used in Enclosures

ANSI/IEEE C 57.109 - Guide for Transformer Through-Fault-Current Duration

NFPA 70E Electrical Safety in Work Place

1.4 CONTRACTOR SUBMITTAL

- A. The short circuit protective device coordination report shall conform to the requirements of this Section entitled "Power Systems Study."
- B. Studies related to distribution system protection and coordination shall be submitted to the District prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient detail to ensure that device selection will be adequate. Preliminary submittal shall indicate the computer program (preferably SKM) for use in performing the work of this section. Submit both hard copy and electronic version including **completed SKM databases** to the District for review and approval. Submittal shall be neatly arranged in a three-ring binder with a CD holder for the database and electronic version of the entire submittal.
- C. Protective device and coordination evaluation studies must be approved by the District prior to system implementation and testing.

PART 2 PRODUCTS

2.1 GENERAL

- A. The study organization shall prepare a single-line diagram of the power system. This diagram shall identify all components considered in the study, and the ratings of all power devices (This includes, but is not limited to: transformers, circuit breakers, relays, fuses, buses, conduit material and cables). The study input data shall include the power company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

2.2 SHORT CIRCUIT STUDY (SC)

- A. The short circuit study shall be performed with the aid of a digital computer program and shall be in accordance with ANSI C37.5, IEEE Standard 242, and IEEE Standard 141. The short circuit study shall include a minimum of two general groups of system-wide calculations including 3-phase bolted faults and single-phase line-to-ground faults. The study shall produce a minimum of 3 complete system-wide sets of data and calculation results including 3 sets covering 3-phase bolted faults and 6 sets covering single-phase line-to-ground faults. The 3 sets of data and results for each group shall correspond to switching, motor and power supply operating arrangements for the worst-case faults on the bus of:
1. Existing Main Service Switchboard.
- B. Typical operating arrangements for worst-case faults are indicated in Table 1

**SHORT CIRCUIT STUDY
OPERATING ARRANGEMENTS FOR WORST-CASE FAULTS**

TABLE 1

Short Circuit Case	Main Bus Energized	Circuit Breaker
480V service available (bolted 3-phase fault)	Entire Distribution System	600A Main Breaker
Same as above (ground fault)	Entire Distribution System	600A Main Breaker
480V PG&E service fails and permanent standby power generator running.	Entire Distribution System	600A Main Breaker

2.3 PROTECTIVE DEVICE EVALUATION STUDY (PDEC)

- A. A protective device evaluation study shall be performed to determine the adequacy of current transformers, circuit breakers, molded case switches, relays, fuses, and other protective devices by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the Engineer's attention.

2.4 PROTECTIVE DEVICE COORDINATION STUDY (PDEC)

- A. A protective device coordination study shall be performed to provide the necessary calculations required to select or check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.
- B. The Contractor shall request information from PG&E and District regarding available short circuit values (three-phase bolted and ground faults) at the secondary side of the service transformer. Unless instructed otherwise by PG&E during construction, the Contractor shall use 42,000 amps as the value of the available short circuit.

2.5 TIME / CURRENT COORDINATION CURVES (PDEC)

- A. As a minimum, the time current coordination curves for the power distribution system shall include the following on 5 cycle log-log graph paper:
 - 1. Time-current curve for each circuit breaker, protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified; relay taps and time dial settings shall be specified. Curves shall be provided for ground fault settings as well as phase bolted fault settings.
 - 2. Time-current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Engineer shall be notified as to the cause.
 - 3. Time-current curves and points for transformer, motor, bus, cable and equipment damage.
 - 4. Circuit interrupting device operating and interrupting times.
 - 5. Indicate maximum fault values on the graph.
 - 6. Sketch of bus and breaker arrangement.
 - 7. Magnetizing inrush points of transformers.
 - 8. Motor starting currents and thermal limits of motors 150 HP and above.
 - 9. All restrictions of the ANSI and National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristics curves shall be maintained.

2.6 ARC FLASH STUDY

- A. The Contractor shall use data and results of the short circuit study to perform an arc flash study which covers the new equipment such as main service switchboard, motor starters. The study shall utilize SKM software to provide results of the equipment hazard category and recommended labeling to apply with NPPA 70E. Label shall be affixed to the electrical equipment as required by NEC Section 110.16. The labels shall show relevant data such as Hazard Risk Category, approaches, PPE, identification of the equipment, voltage, name and phone of the study performer, date of study etc. In addition, general arc flash warning labels shall also be provided for each electrical panel, MCC etc.
- B. The Contractor shall specifically address the results of the arc flash study for location where "Dangerous" category is found, and shall suggest means or methods to reduce the "Dangerous" category to 4 or 3 or better.

PART 3 EXECUTION

3.1 PROTECTIVE DEVICE TESTING, CALIBRATION TESTING, CALIBRATION AND ADJUSTMENT

- A. The Low Voltage MCC or switchboard manufacturer shall provide the services of a NETA certified, third party testing company with necessary tools and equipment to test, calibrate, and adjust the protective relays, motor protection devices, and circuit breaker trip devices as recommended in the power system coordination study.

3.2 STUDY REPORT

- A. The results of the power system study shall be summarized in a final report. Four copies in three-ring binders of the final report signed and sealed with a California registered electrical PE stamp and signature shall be submitted. The report shall include the following:
 - 1. Description, purpose, basis, criteria, scope and assumptions of the study.
 - 2. Single-line diagram drawings which shall show ALL relevant data such as calculated short circuit values, short circuit rating of each equipment, short circuit contributions, and device (open/close) status. One full size drawing 24"x36" showing the single-line diagram with pertinent data shall be submitted, folded in the submittal in addition to a half-size drawing set.
 - 3. Tabulation of all protective devices, KVA ratings of equipment, cable size and ampacities and motor contributions, short circuit values, all of which shall be identified on the single line diagram. Devices ratings versus calculated short circuit duties, and commentary regarding same. Device settings versus transformer inrush currents, motor starting currents and calculated short circuit currents and commentary regarding same.
 - 4. Time/current coordination, colored curves for all protective devices.

5. Computerized fault current calculations and input data.
6. Specific recommendations on equipment ratings, protective device settings and ratings.
7. Equipment and wire input data impedances shall be clearly listed.
8. Instrumentation, condition, and connections for each study
9. Transformer, motor and cable damage curves.
10. Equipment hazard category and labels.

3.3 RECOMMENDED CHANGES

- A. If recommended changes in breakers or fuses or protective devices will provide coordination where coordination was not originally possible, the Contractor shall incorporate these changes at no additional cost to the District. Additional protective devices recommended by this study, not shown or specified in the Contract Documents, may be proposed, but are not part of the requirements of the Contract Documents.

3.4 FINAL STUDY REPORT

- A. After all the District's submittal comments and any setting revisions to the equipment have been incorporated, a Final Study Report (hard copy and electronic version containing all data bases) shall be submitted to the Engineer prior to implementation of the settings.
- B. Computer disk copies of the report input and output data shall be submitted with the final report in addition to the 4 bound copies. The SC, LF and PDEC computer program name version and phone number and address of the manufacturer shall be indicated.

Affix calculated arc flash labels on electrical equipment. Labels shall be weather-proof suitable for outdoor usage. Provide 200 spare, self-adhesive generic/general arc flash labels to the District.

END OF SECTION

SECTION 16940 ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Acceptance testing of electrical system, wiring, equipment, and grounding.
- B. Related Sections:
 - 1. 16000 – Requirements for Electrical Work.

1.2 REFERENCES

- A. National Electrical Testing Association (NETA):
 - 1. ATS-2013: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
- B. ANSI: Test Procedures for Electrical Equipment.
- C. ASTM: American Society for Testing and Materials.
- D. ANSI/IEEE: Recommended Practices for Testing: Machinery, Ground Impedance, Cables and Terminations.

1.3 SUBMITTALS

- A. Pre-Test Submittals:
 - 1. Testing service qualifications.
 - 2. Test personnel qualifications (resumes).
 - 3. Equipment testing schedule.
 - 4. Test data forms, custom edited for difference types of electrical equipment.
- B. Post-Test Submittals: Summary Test Report consists of the following:
 - 1. Summary of testing for the project.
 - 2. Description of the equipment tested.
 - 3. Description of the test and test procedures.
 - 4. Test results for each apparatus and motorized equipment.

5. Conclusions and recommendations.
 6. Completed test forms, including witness's signatures.
 7. List of test equipment and calibration documents.
 8. Date and time.
 9. A copy of this specification section with each paragraph check marked indicating compliance or marked with explicit deviations.
- C. Submit Equipment Testing Schedule no later than 7 days prior to scheduled date of testing.
- D. Project Record Documents: Submit as specified in Section 16000. Note or indicate wiring deviations from Contract Documents on Project Record Documents.
- 1.4 QUALITY ASSURANCE
- A. Testing Firm Qualifications:
1. Obtain the services of an independent testing service firm that meets the Federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7 and has a work history and qualifications acceptable to ENGINEER.
 2. Prequalified Testing Services and Manufacturing Firms:
 - a. General Electric Company.
 - b. Square D Company Technical Service Divisions.
 - c. Electrical Reliability Services
 - d. Siemens/Westinghouse Technical Services.
 3. Testing service or testing personnel may be accepted or rejected based upon, but not limited to, the testing equipment intended to be used, the qualifications of the firm, and personnel.
- B. Test Equipment Traceability:
1. Testing firm shall have a calibration program to maintain test instrumentation and equipment within rated accuracy, including stickers with calibration dates record.
 2. Equipment and instruments used to evaluate electrical performance shall be calibrated to a standard traceable to the National Institute of Standards and Technology.
 3. Test equipment operating instructions and procedures shall be with the test equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 SAFETY AND PRECAUTIONS

- A. Testing firm shall perform tests following a safe practice in accordance with OSHA and accident prevention procedures by National Safety Council and applicable codes.
- B. Tests shall be performed with apparatus de-energized, except as necessary for equipment performance and functional test.

3.2 EXAMINATION

- A. Verify that electrical work is free from improper grounds, short circuits, and overloads.
- B. Verify correctness of wiring first by visual comparison of the conductor connections with connection diagrams.
- C. Make individual circuit continuity checks by using electrical circuit testers.
- D. Verify correctness of wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

3.3 IMPLEMENTATION OF POWER SYSTEMS STUDIES

- A. Prior to perform acceptance testing, the testing firm shall inspect and verify adequate short circuit rating of electrical equipment as determined by the short circuit study specified in Section 16938.
- B. The testing firm shall implement the adequate settings and calibration of protective relays, circuit breakers, fuses and other applicable protective devices as recommended in the protective devices coordination study in Section 16938.

3.4 ACCEPTANCE TESTING

- A. General Requirements:
 - 1. Perform testing and allow DISTRICT and ENGINEER to witness testing.
 - 2. Perform tests to assure that electrical equipment will operate within industry and manufacturer's published tolerances, and will perform safely. Record test result data, to be used as a baseline for future tests.
 - 3. Test motorized equipment to verify conformance with the Contract Documents and for acceptance.
 - 4. Equipment for which acceptable test data has not been submitted, or has been submitted but rejected, shall be deemed as not meeting Contract requirements.
- B. Equipment and Materials Inspection and Test Procedures. Complete test reports for each individual piece of equipment and systems:
 - 1. Switchboard Assemblies (Low Voltage):

- a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical, electrical, and mechanical condition.
 - 3) Confirm correct application of manufacturer's recommended lubricants.
 - 4) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
 - 5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
 - 6) Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
 - 7) Verify that current and potential transformer ratios correspond to drawings.
 - 8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - b) Make key exchange with devices operated in off-normal positions.
 - 10) Clean Switchboard.
 - 11) Inspect insulators for evidence of physical damage or contaminated surfaces.
 - 12) Verify correct barrier and shutter installation and operation.
 - 13) Exercise all active components.
 - 14) Inspect all mechanical indicating devices for correct operation.
 - 15) Verify that filters are in place and/or vents are clear.
 - 16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding.
 - 17) Inspect control power transformers.
 - a) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - b) Verify that primary and secondary fuse ratings or circuit breakers match drawings.
 - c) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.
- b. Electrical Tests:
 - 1) Perform tests on all instrument transformers.
 - 2) Perform ground-resistance tests.
 - 3) Perform resistance tests through ball bus joints with a low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closet accessible connection.
 - 4) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.

- 5) Perform an overpotential or megger test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.
 - 6) Perform control wiring performance test.
 - 7) Perform current injection tests on the entire current circuit in each section of switchboard.
 - 8) Determine accuracy of all meters and calibrate.
 - 9) Perform phasing check on double-ended switchboard to insure correct bus phasing from each source.
 - 10) Perform the following tests on control power transformers.
 - a) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.
 - b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm correct potential at all devices.
 - c) Verify correct function of control transfer relays located in switchgear with multiple power sources.
 - 11) Potential Transformer Circuits:
 - a) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
 - 12) Verify operation of switchgear/switchboard heaters.
2. Protective Relays: All relays installed on switchboard shall be tested regardless if the units are not indicated on the subsequent list.
- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate data with drawing and specifications.
 - 2) Inspect relays and cases for physical damage. Remove shipping restraint material.
 - 3) Tighten case connections. Inspect cover for correct gasket seal. Clean cover glass. Inspect shorting hardware, connection paddles, and/or knife switches. Remove any foreign material from the case. Verify target reset.
 - 4) Inspect relay for foreign material, particularly in disc slots of the damping and electromagnets. Verify disk clearance. Verify contact clearance and spring bias. Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and/or pivots.
 - 5) Set relays in accordance with coordination study supplied by Power System Study, Section 16938..
 - b. Electrical Tests
 - 1) Perform insulation-resistance test on each circuit-to-frame. Determine from the manufacturer's instructions the allowable procedures for this test for the solid-state and microprocessor-based relays.
 - 2) Inspect targets and indicators
 - a) Determine pickup and dropout of electromechanical targets.
 - b) Verify operation of all light-emitting diode indicators.
 - c) Set contrast for liquid-crystal display readouts.

3. Instrument Transformers

a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
- 2) Inspect physical and mechanical condition.
- 3) Verify correct connection of transformers with system requirements.
- 4) Verify that adequate clearances exist between primary and secondary circuit wiring.
- 5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- 6) Verify that all required grounding and shorting connections provide contact.
- 7) Verify correct operation of transformer withdrawal mechanism and grounding operation.
- 8) Verify correct primary and secondary fuse sizes for potential transformers.

b. Electrical Tests - Current Transformers

- 1) Perform insulation-resistance test of the current transformer and wiring-to-ground at 1000 volts dc. Do not perform this test on solid-state devices.
- 2) Perform a polarity test of each current transformer.
- 3) Perform a ratio-verification test using the voltage or current method in accordance with ANSI C57.13.1 (IEEE Guide to Field Testing of Relaying Current Transformers).
- 4) Measure current circuit burdens at transformer terminals and determine the total burden.

c. Electrical Tests - Voltage Transformers

- 1) Perform insulation-resistance test winding-to-winding and each winding-to-ground. Do not perform this test with solid-state devices connected.
- 2) Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.
- 3) Perform a turns ratio test on all tap positions, if applicable.

4. Metering

a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
- 2) Inspect physical and mechanical condition.
- 3) Verify tightness of electrical connections.
- 4) Inspect cover gasket, cover glass, conditions of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
- 5) Verify mechanically for freedom of movement, correct travel and alignment, and tightness of mounting hardware.

b. Electrical Tests

- 1) Check calibration of meters at all cardinal points.
- 2) Verify all instruments multipliers.
- 3) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

5. Transformers

a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
- 2) Inspect physical and mechanical condition.
- 3) Verify removal of any shipping bracing after final placement.
- 4) Inspect impact recorder prior to unloading, if applicable.
- 5) Verify that alarm, control, and trip settings on temperature indicators are as specified.
- 6) Verify that cooling fans and pumps operate correctly and that fan and pump motors have correct overcurrent protection.
- 7) Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.
- 8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- 9) Verify correct liquid level in all tanks and bushings.
- 10) Verify that positive pressure is maintained on nitrogen-blanketed transformers.
- 11) Perform specific inspections and mechanical tests as recommended by manufacturer.
- 12) Verify correct equipment grounding.

b. Electrical Tests

- 1) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground with test voltage. Test duration shall be for ten minutes with resistances tabulated at thirty seconds, one minute, and ten minutes. Calculate polarization index.
- 2) Perform a turns-ratio test on all no-load tap-changer positions and all load tap-changer positions. Verify that tap setting is as specified. Verify that winding polarities are in accordance with nameplate.
- 3) Measure resistance of each high-voltage winding in each no-load tap-changer positions. Measure resistance of each low-voltage winding in each load tap-changer position, if applicable.
- 4) If core ground strap is accessible, measure core insulation resistance at 500 volts dc.

c. Test Values

- 1) Bolt-torque levels shall be in accordance with data by manufacturer.
- 2) Insulation-resistance test values.
- 3) The polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
- 4) Turns-ratio test results shall not deviate more than one-half percent from either the adjacent coils or the calculated ratio.
- 5) Consult manufacturer if winding-resistance measurements vary more than one percent from adjacent windings.
- 6) Consult manufacturer if core insulation is less than one megohm at 500 volts dc.

6. Low-Voltage Power Circuit Breakers where shown on the drawings.

a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
- 2) Inspect physical and mechanical condition.
- 3) Confirm correct application of manufacturer's recommended lubricants.
- 4) Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
- 5) Verify that all maintenance devices are available for servicing and operating the breaker.
- 6) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- 7) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.
- 8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Refer to manufacturer's instructions.
- 9) Check cell fit and element alignment.
- 10) Check racking mechanism.
- b. Electrical Tests
 - 1) Perform a contact-resistance test.
 - 2) Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
 - 3) Make adjustments for the final settings in accordance with the coordination study supplied by Power System Study, Section 16938..
 - 4) Determine minimum pickup current by primary current injection.
 - 5) Determine long-time delay by primary current injection.
 - 6) Determine short-time pickup and delay by primary current injection.
 - 7) Determine ground-fault pickup and delay by primary current injection.
 - 8) Determine instantaneous pickup value by primary current injection.
 - 9) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to insure operation of shunt trip devices. Check the operation of electrically-operated breakers in their cubicles.
 - 10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free and antipump function.
 - 11) Check charging mechanism.
- c. Test Values
 - 1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
 - 2) Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent.
 - 3) Insulation resistance shall not be less than 100 megohms. Investigate values less than 100 megohms.
 - 4) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands.

7. Motor Control Centers, Motor Controllers and Motor Starters: Low Voltage
 a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- b. Electrical Tests
- 1) Insulation Tests
 - a) Measure insulation-resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Test voltage shall be in accordance with manufacturer's instructions for devices with solid-state components.
 - b) Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

Note: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison. (Refer to NEMA ICS 2-1993, Part 4.)

- c. Test Values
- 1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
 - 2) Insulation-resistance values.
 - 3) Overload trip times shall be in accordance with manufacturer's published data.
- d. Motor Control Center Bus
- 1) See section switchgear assemblies for inspection and tests of MCC bus.

8. Circuit Breakers: Low-Voltage Molded Case - 100 Amp or Larger Only

- a. Visual and Mechanical Inspection
- 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect circuit breaker for correct mounting.
 - 3) Operate circuit breaker to insure smooth operation.
 - 4) Inspect case for cracks or other defects.
 - 5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
- b. Electrical Tests
- 1) Perform a contact-resistance test.
 - 2) Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
 - 3) Perform adjustments for the final settings in accordance with the coordination study.
 - 4) Perform long-time delay time-current characteristics tests by passing 300 percent through each pole separately unless series testing is required to defeat ground fault functions.

- 5) Determine short-time pickup and delay by primary current injection.
 - 6) Determine ground-fault pickup and time delay by primary current injection.
 - 7) Determine instantaneous pickup current by primary injection using run-up or pulse method.
 - 8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
 - c. Test Values
 - 1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
 - 2) Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent. Investigate any value exceeding manufacturer's recommendations.
 - 3) Insulation resistance shall not be less than 100 megohms.
 - 4) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands, including adjustment factors.
9. Rotating Machinery: AC Motors
- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
 - 4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 5) When applicable, perform special tests such as air gap spacing and pedestal alignment.
 - 6) Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
 - b. Electrical Tests: Induction Motors
 - 1) Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
 - a) Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.
 - b) Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
 - 2) Test motor starter in accordance with Section 7.16 of these specifications.
 - 3) Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
 - 4) Verify that the motor space heater is functional.
 - 5) Perform a rotation test to insure correct shaft direction.
 - 6) Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

10. Capacitors where shown on the drawings:
- a. Visual and Mechanical Inspection

- 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect capacitors for correct mountings and required clearances.
 - 4) Verify that capacitors are electrically connected in their specified configuration.
11. Low-Voltage Surge Protection Devices where shown on the drawings:
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect for correct mounting and adequate clearances.
 - 4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 5) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
12. Dry Type Transformers
 - a. Air-Cooled, 600 Volt and Below (167kVA Single-Phase, 500 kVA Three-Phase and Smaller)
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify that resilient mounts are free and that any shipping brackets have been removed.
 - 4) Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and each winding-to-ground. Test voltages and minimum resistance.
 - 5) Verify that winding turns-ratio measurements and polarities are in accordance with nameplate.
 - 6) Verify that as-left tap connections are as specified.
13. Grounding Systems
 - a. Visual and Mechanical Inspection
 - 1) Verify ground system is in compliance with drawings and specifications.
 - b. Electrical Tests
 - 1) Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the main grounding electrode or system.
 - 2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
 - c. Test Values
 - 1) The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating grounds unless otherwise specified.
 - 2) Investigate point-to-point resistance values which exceed 0.5 ohm.

14. Ground-Fault Protection Systems

- a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate and data with drawings and specifications.
 - 2) Visually inspect the components for damage and errors in polarity or conductor routing.
 - 3) Verify tightness of all electrical connections including control circuits.
 - 4) Verify correct operation of all functions of the self-test panel.
 - 5) Verify that the control power transformer has adequate capacity for the system.
 - 6) Set pickup and time-delay settings in accordance with the settings provided in the coordination study. Record appropriate operation and test sequences as required by NEC Article 230-95.
- b. Electrical Tests
 - 1) Verify that relay does not operate at 90 percent of the pickup setting.

15. Low-Voltage Cables: 600 Volt

- a. Visual and Mechanical Inspection
 - 1) Compare cable data with drawings and specifications.
 - 2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - 4) Inspect compression-applied connectors for correct cable match and indentation.
 - 5) Verify cable color coding with applicable engineer's specifications and National Electrical Code standards.
- b. Electrical Tests
 - 1) Perform a insulation resistance test on all cables.

16. Systems Function Tests

- a. Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the correct interaction of all sensing, processing, and action devices.
- b. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements. Perform these tests.
- c. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
- d. Verify the correct operation of all sensing devices, alarms, and indicating devices.

3.5 SUMMARY TEST REPORT

- A. Upon completion of testing of all electrical equipment, submit summary test report in a 3-ring binder with proper tabs and table of contents for review and approval.

END OF SECTION