PORT OF TACOMA
TACOMA, WASHINGTON
WEST SITCUM STORMWATER TREATMENT

PROJECT NO. 201024.01
CONTRACT NO. 070664
VOLUME 2 OF 2

Jane Vandenberg, PE

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Project Manager

END OF PROJECT TITLE PAGE

CONTRACT DOCUMENTS

PORT OF TACOMA

WEST SITCUM STORMWATER TREATMENT

CONTRACT NO. 070664; PROJECT NO. 201024.01

THE UNDERSIGNED ENGINEER OF RECORD HEREBY CERTIFIES THAT THE TECHNICAL SPECIFICATIONS FOR THE FOLLOWING PORTIONS OF THIS PROJECT MANUAL WERE WRITTEN BY ME, OR UNDER MY DIRECT SUPERVISION, AND THAT I AM DULY REGISTERED UNDER THE LAWS OF THE STATE OF WASHINGTON, AND HEREBY AFFIX MY PROFESSIONAL SEAL AND SIGNATURE. THOSE SECTIONS PREPARED UNDER OR BY SUPERVISION AND BEING CERTIFIED BY MY SEAL AND SIGNATURE ARE AS FOLLOWS:

PARAMETRIX, INC.

SEAL & SIGNATURE	SECTION(S)
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Prepared by Jennifer Elise Murphy, P.E.	

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SEAL & SIGNATURE	SECTION(S)
 4/6/2018	02 32 00 02 41 00 31 23 19 31 23 33 32 12 16 33 44 19 33 44 43
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END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide all demolition required to perform the work covered under this contract including without limitation:

1. Remove existing structures and piping shown to be removed.
2. If utilities that are not shown pass through the work area must be relocated, notify the Engineer before disrupting service.
3. Store and protect items intended for reuse.
4. Assume ownership of debris and unwanted materials, remove from the site and dispose. Provide the Owner copies of documentation certifying disposal in accordance with regulatory agencies.
5. If illegal electrical wiring is encountered such as “BX” or nonmetallic sheathed cable, notify the Engineer. Proceed with other available work after notification is made.

1.02 NOISE AND DUST CONTROL

A. Perform work in accordance with requirements in Section 01 35 47.

B. Perform work in a manner to avoid disturbance to site operations and minimizes damage to the remaining work.

1.03 REFERENCE DOCUMENTS

A. Not Used

PART 2 - PRODUCTS

2.01 REMOVAL OF CONSTRUCTION IN AREAS TO RECEIVE NEW WORK

A. Provide careful selective cutting and removal of existing construction where required to perform work.

B. Replace and/or patch removed pavement and finishes in accordance with other parts of this section.

C. Remove structural work designated for removal. Take precautions not to damage structural work intended to remain. Where temporary shoring is needed, submit a design prepared in accordance with Section 31 23 33 - Earthwork.

2.02 PROTECTION OF WORK TO REMAIN

A. Protect all work to remain. Repair damage with materials, workmanship and finishes matching existing work when new.

2.03 DISPOSAL OPERATIONS

A. Excavated Materials:

1. Spoil Material:

a. Remove all material which is excavated and stockpile for Owner testing. Allow 21 days for testing. Stockpile location shall be determined by the Engineer.

b. Rubbish shall consist of all materials not classified as suitable materials or rubble and shall include shrubbery, trees, timber, trash, and garbage, and shall be disposed of off-site as part of this Contract.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This specification describes the polymer modified cementitious patching and repair of the existing oil water separators within Basins B and C.

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer of the specified product shall be ISO 9001 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. Contractor Qualifications: The Contractor shall be qualified in the field of concrete repair with a successful track record of 5 years or more. The Contractor shall maintain qualified personnel who have received product training by a manufacturer's representative.

C. Install materials in accordance with all safety rules and regulations of local, state, and federal laws and authorities. Consult Safety Data Sheets for complete handling recommendations.

D. Install materials in accordance with manufacturer's requirements for safe handling and environmental conditions.

1.03 DELIVERY, STORAGE AND HANDLING

A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Store all materials off the ground and protect from rain, freezing, or excessive heat until ready for use.

C. Condition the specified product as recommended by the manufacturer.

1.04 JOB CONDITIONS

A. Environmental Conditions: Dry and minimum application temperature of 45 degrees F.

B. Protection: Precautions shall be taken to avoid damage to any surface near the work zone due to mixing and handling of the materials.

C. Materials and work shall conform to the requirements of standards and recommended practices required in this section. In conflicts between industry standards, required standards, and this specification, or this specification and the local building code, the more stringent requirement shall govern.

1.05 SUBMITTALS

A. All submittals shall be in accordance with Section 01 33 00.

B. Submit two copies of manufacturer's literature, to include:

1. Product Data Sheets.

2. Safety Data Sheets (SDS).

1.06 STORAGE OF MATERIALS

A. Maintain in continuous clean environment and in manner required to maintain homogeneity.

B. Cements, grouts, and mortar containerized and kept in dry humidity environment. Engineer shall reject materials which have hardened or show any evidence of initial hydration.

1.07 PRODUCT WARRANTY

A. Provide a written warranty from the manufacturer against defects of materials for a period of 1 year, beginning from the date of material application.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Polymer-modified Portland cement mortar.
   1. Product:
      a. SikaTop 123 Plus by Sika Corporation.
      b. MasterEmaco N400 by Master Builders BASF.
      c. Or approved equal.
   2. Performance Criteria:
      a. Compressive Strength: 1 day 2,300 psi, 7 day 4,500 psi.
      b. Flexural Strength: 1,000 psi at 28 days.
      c. Bond Strength: 2,200 psi at 28 days (ASTM C 882 Modified).
      d. Placeable from 1/8 inch to 1-1/2 inches in depth per lift for vertical applications and 1/8 inch to 1 inch in depth for overhead applications.
   3. Materials shall be supplied in factory-proportioned units.

B. Epoxy-modified, cementitious, anti-corrosion coating for reinforcing steel and concrete bonding agent:
   1. Product:
      a. Sika Armatec 110 EpoCem by Sika Corporation.
      b. MasterEmaco N400 by Master Builders BASF.
      c. Or approved equal.
   2. Performance Criteria:
      a. Compressive Strength: 7 day 6,500 psi.
      b. Flexural Strength: 1,000 psi.
      c. Bond Strength: Wet-on-wet 2,800 psi; 2,000 psi at 24 hours open time.

C. Form Release Agent:
   1. Water-based material compatible with the specified patching materials, DUOGARD by W. R. Meadows, NOX-Crete Form Coating E by Nox-Crete, Clean Strip J1EF by Dayton Superior, or approved equal. No petroleum based release agents shall be allowed.

D. Curing Compound:
   1. Water based, pigmented curing compound shall be used, compatible with the specified patching materials, 1600-WHITE by W.R. Meadows, DOT Road Cure by Nox-Crete, or approved equal.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Clean with high-pressure water washer to remove wastewater contaminants and remove loose concrete. Contain water and debris and dispose of off-site in an approved manner. Do not allow these materials to enter the storm water system.

B. Remove loose and failing original patch materials with impact hammers or rivet guns.

C. Roughen surface by mechanical means to obtain a surface profile of +/- 1/16 inch (CSP 5 or greater as per ICRI Guidelines) with a new exposed aggregate surface. Area to be patched shall not be less than 1/8 inch in depth.

D. Where reinforcing steel is exposed and rusted, wire brush to remove all loose rust and coat with two coats of Epoxy-modified, cementitious, anti-corrosion coating applied per the manufacturer's written instructions.

3.02 MIXING MORTAR

A. Mechanically mix component parts as directed by manufacturer's written instructions.

B. Should smaller quantities be needed, be sure the components are measured in the correct ratios. Mix only that amount of material that can be placed in 10 to 15 minutes. Do not retemper material.

3.03 PLACEMENT

A. At the time of application, the substrate shall be saturated surface dry with no standing water.

B. Preparation Coat:

1. Apply Epoxy-modified, cementitious, anti-corrosion coating/ bonding agent to all contact surfaces.

C. Fill repair area with specified materials, building up in lifts of 1 inch maximum or using forms as required to support the material in contact with the beams.

1. If multiple lifts are required to fill the voids, score the surface of each preceding lift to provide a rough bonding surface.

2. Apply fresh mortar scrub coat before placing next lift of material.

D. Screed or form flush to surface of existing concrete.

3.04 CURING AND PROTECTION

A. Apply specified curing compound as soon as practicable, in accordance with the manufacturer's recommendations.

3.05 CLEANUP

A. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Standards:

1. ACI 318-14 Building Code Requirements for Structural Concrete, Section 26.11.
2. ACI 347 Recommended Practice for Concrete Formwork.
3. ACI 301 Specifications for Structural Concrete for Buildings.
4. U.S. Product Standard PS 1 for Plywood.
5. Standard Grading and Dressing Rules No. 17 of the West Coast Lumber Inspection Bureau.

1.02 DELIVERY, STORAGE, AND HANDLING

A. On delivery to jobsite, place materials in an area protected from weather.

B. Store materials aboveground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.

C. Handle materials to prevent damage.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Plywood: New or in new condition “B-B Plyform Class 1 Exterior” grade plywood, 5/8-inch minimum thickness.

B. Steel Panels: Flat steel sheet or plate of sufficient thickness, or braced sufficiently, to prevent noticeable deflection from pressure of concrete. Steel forms galvanized and/or coated to prevent rust and staining.

C. Framing, Studding, and Bracing: “Standard” or “Construction” grade West Coast Species lumber.

D. Form Ties: Prefabricated rod of the cone-type snap-tie configuration, or approved threaded internal disconnecting type, to resist all imposed loads of freshly placed concrete, and permit tightening and spreading of forms. Plastic cone snap-ties shall break back 1 to 1-1/2 inches.

E. Form Coating: Lacquer, plastic, or epoxy coating, or nonstaining form oil that will not impair the bonding quality for final finish of the painting or protective coating. Coatings containing mineral oils or other nondrying ingredients will not be permitted.

F. Shores and Falsework: Standard patented, manufactured shores, or sound commercial construction lumber.

G. Chamfer Strips: Chamfer strips (for all edges exposed to view) 3/4-inch, 45-degree bevel wood strips or reusable plastic triangular strips.

PART 3 - EXECUTION

3.01 DESIGN OF FORMWORK

A. Design formwork to safely support vertical and lateral loads, which might be applied until such loads can be supported by the concrete structure. Carry vertical and lateral loads by formwork system to ground or to in-place construction, which has attained adequate strength for that purpose.

B. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

C. Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

D. Form facing materials shall be supported by structural members spaced to prevent deflection. Design camber in formwork as required for anticipated deflections.

E. Design formwork to be readily removable without impact, shock, or damage to cast in place concrete surfaces and adjacent material.

F. Keep oil or other agents from getting on reinforcing steel, embedded items, or other surfaces requiring bond with concrete.

3.02 LAYOUT OF FORMWORK

A. Locate and stake out all forms and establish all lines and levels and elevations.

3.03 CONSTRUCTION OF FORMS

A. Formwork - General:

1. Before concrete is placed in any form, verify horizontal and vertical form position and correct all inaccuracies. Complete all wedging and bracing in advance of placing of concrete.

2. When setting form ties leave no metal to remain in walls closer than 1 inch from surface. Ties shall fit tight to prevent mortar leakage at holes in forms. Ties shall be protected from rusting at all times. No wire ties or wood spreaders will be permitted. Cutting ties back from concrete face will not be permitted.

3. At construction joints, anchor forms by using an adequate number of form ties in the new pour a few inches from the construction joints. Do not rely on ties adjacent to the joint used in previous placements.

4. For exposed concrete, forms shall be of new plywood, metal panel, or approved panel materials, smooth, and continuous.

5. For unexposed concrete, forms shall be plywood, metal, boards, or approved material. Boards, nominal 1-inch-minimum thickness, sound and tight, commercial construction lumber, shiplapped or tongue-and-grooved, dressed on at least one side and both edges for tight fit. Use plywood, metal, or approved material equal to or better than board surface.

B. Chamfered Corners: Chamfer all corners that will be exposed to view 3/4 inch, unless shown otherwise on Drawings. Provide 45-degree triangular moldings in forms for all chamfering required.

1. Inspection and Cleanout Openings: Provide inspection and cleanout openings at the bottom of all forms for columns, pilasters, walls over 8 feet in height, and for forms for irregularly shaped placement where cleaning and inspection from the top would be impractical.

C. Coordination: Coordinate the installation of all items to be inserted or embedded in concrete. Support all items to maintain accurate alignment and prevent distortion during concrete placement.

D. Cleaning: All dirt, chips, sawdust, mud, water, and other foreign matter shall be removed from within the forms or within the excavated areas before any concrete is deposited therein.

3.04 NOTIFICATION AND INSPECTION

A. Prior to placing of any concrete, and after placement of reinforcing steel in the forms, notify the Engineer at least 24 hours in advance of placing concrete to permit inspection.

3.05 DEFECTIVE WORK

A. Any form movement or deflection during construction or finished surface variations in excess of the tolerances specified will be basis for rejection of cast-in-place product and requirement for replacement of same.

3.06 REMOVAL OF FORMS

A. Do not remove forms and supports until concrete has attained sufficient strength to support anticipated loads.

B. The listing below serves only as a guide in determining the minimum length of time required before removal of forms and is based on the use of Type I portland cement. When high early strength portland cement is used, the length of time listed below may be reduced to not less than one-third time listed, but not less than 1 day.

1. Walls in Mass Work: 24 hours.
2. Thin Walls (12 inches or less): 48 hours.
3. Columns: 7 days.
4. Bottom Forms and Supports of Beams, Girders, and Slabs: 14 days.

C. Use methods of form removal that will not cause overstressing of the concrete. Remove supports to permit the concrete to uniformly and gradually take the stress due to its own weight. Do not use high impact methods to remove supports.

D. Break back ties after concrete has cured sufficiently to maintain unbroken bond with steel rod.

3.07 REUSE OF FORMS

A. Any reused form for exposed concrete work shall be reconditioned to “like new” condition. Any reused form shall be cleaned, repaired, and recoated before each reuse.

3.08 BLOCK OUTS

A. Where pipes, castings, or conduits pass through the walls, place such pipes or castings in the forms before pouring the concrete, or in special cases, with the express consent of the Engineer or as specified, build accepted boxes in the forms to make cored openings for subsequent insertion of such pipes, castings, or conduits. Provide boxes or cores with slight flare to facilitate grouting and the escape of entrained air during grouting.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the materials and installation requirements for metal embedment into concrete or grouted masonry.

B. Items Included:

1. Cast-in-place anchor bolts (anchor rods).
2. Manufactured cast-in-place inserts for suspended piping or electrical items.
3. Inserts for structural attachments.
4. Collars or sleeves for pipe penetrations.
5. Post-installed anchors.

1.02 SUBMITTALS

A. Shop Drawings for all anchors, inserts, and embedded products (wall castings, pipes with seep rings, and special castings or fabrications).

B. Manufacturer’s Data: Submit complete data for fasteners including materials, dimensions, resins, colors, and other information.

C. Current ICBO Evaluation Reports for all expansion and adhesive anchors.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cast-in-place Anchor Bolts: ASTM F 1554 Grade 36 or ASTM A 307, galvanized steel unless otherwise noted. Configuration shall be as shown or noted on the Drawings.

B. Expansion (Wedge) Anchors: ICBO approved for use in cracked and uncracked concrete for all anchors used for wind or seismic anchorage applications.

1. All anchors to be Stainless Steel complying with the following:
    a. Stud: Stainless steel bar conforming to ASTM A 276 with chemical composition of either AISI 304 or 316.
    b. Wedge: Manufactured from either AISI 304 or 316 stainless steel.
    c. Nut: Stainless steel conforming to ASTM F 594 with chemical composition of either AISI 304 or 316 and meeting dimensional requirements of ANSI B18.2.2.
    d. Washer: AISI 304 or 316 stainless steel conforming to ASTM A 240.
2. Products:
    a. Hilti, Kwik-Bolt TZ.
    b. Powers Fasteners, Power-Stud, and SD1 and SD2.
    c. Simpson Strong Tie, Strong-Bolt.
    d. Or approved equal.

C. Adhesive Anchors:

1. Anchor rod material shall conform to ASTM A 304 stainless steel unless ASTM A 316 is called out on the Drawings.

2. Products:
    a. Hilti, HIT-RE 500-SD.
    b. Powers Fasteners, PE1000+.
    c. Simpson Strong-Tie, SET-XP.
    d. Or approved equal.

D. Stainless Steel Plates and Shapes: Conform to AISI Type 304 unless otherwise noted.

PART 3 EXECUTION

3.01 INSTALLATION

A. Coordinate the location and placement of all items to be embedded in concrete.

B. Coat any embedded aluminum with asphalt paint.

C. Adhesive and expansion anchors to be installed in holes drilled with carbide tipped drill bits. Anchors shall be installed per manufacturer's recommendations. Insert and tighten bolts in accordance with manufacturer's installation instructions. In case of interference with reinforcing bars or steel objects, notify the Engineer.

3.02 EMBEDDING

A. Set accurately and hold in position all embedded products during placement until the concrete is set.

3.03 INSPECTION

A. Anchors shall be inspected by Special Inspector as required by the Inspection Requirements described in the Structural General Notes contained on the Drawings or as required by the Building Official.

END OF SECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Manual of Standard Practice for Detailing Reinforced Concrete Structures, ACI 315.

B. *Manual of Standard Practice*, Concrete Reinforcing Steel Institute.

1.02 SUBMITTALS

A. Placing Drawings, Bending, and Cut-Sheet Schedules.

B. Mill test reports for each shipment of reinforcement shall be submitted to the Engineer for review.

C. All wall reinforcement to be shown in elevation on the Shop Drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver reinforcement to project site in bundles marked to coordinate with placement Drawings.

B. Handle and store to prevent contamination from dirt, oil, and other materials, which will affect bond.

C. Store a minimum of 6 inches above ground and in locations where the material will not be subject to abuse.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars: Unless specified otherwise, all bars for concrete reinforcement shall be deformed bars meeting the requirements of ASTM A 615, Grade 60, “Billet Steel Bars for Concrete Reinforcement.”

B. Tie Wire: Steel, black annealed, 16 gauge minimum.

C. Reinforcing Bar Supports: Per CRSI “*Manual of Standard Practice*,” Chapter 3, pregalvanized or plastic coated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Placement and Tolerances: Conform to CRSI Manual of Standard Practice.

B. Splices:

1. Do not splice bars except at locations shown or noted on the Drawings or as otherwise approved.

2. Tie lap splices securely with wire to prevent displacement of splice during placement of concrete.

C. Cleaning: Remove dirt, grease, oil, loose mill scale, excessive rust, and foreign matter that may reduce bond with concrete.

D. Protection during Concreting: Keep reinforcing in proper position during concrete placement.

E. Concrete Cover: Maintain minimum concrete cover over reinforcement as specified in ACI 318 or as noted. Bend tie wire away from concrete surfaces to maintain required clearances.

END OF SECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Materials and work shall conform to the requirements of standards and recommended practices required in this section. In conflicts between industry standards, required standards and this specification, or this specification and the local building code, the more stringent requirement shall govern.

B. Standards:

1. Concrete is designed and controlled by the latest edition of the following:

a. ACI 301, “Specifications for Structural Concrete for Buildings.”

b. Field Reference Manual (ACI Publication SP-15).

2. Contractor shall have available in the field office a copy of the ACI Field Reference Manual SP 15. This field reference manual is a compilation of ACI 301 and selected ACI and ASTM references listed in that specification.

C. Evaluation and Acceptance: Strength level of concrete will be satisfactory if 90 percent of strength test results and averages of all sets of three consecutive strength test results equal or exceed specified strength and not more than 1 test result in 100 is below specified strength by more than 500 psi.

D. Concrete Tests:

1. The Owner shall pay for and the Contractor shall be responsible for coordinating with the Engineer for all field sampling and in-place testing required. Engineer shall be notified 24 hours in advance of all scheduled pours.

2. The Owner will retain and provide an independent Testing Laboratory to perform all sampling and testing services.

3. Non-conforming test results will be made known to the Contractor within 48 hours following their receipt from the Testing Laboratory.

4. Concrete shall be sampled and tested in accordance with ACI 301 during the progress of concrete work. Slump and air content tests shall accompany all test cylinders for strength.

1.02 SUBMITTALS

A. Submit two copies of trial mix designs proposed and one copy each of 30 consecutive test results and the mix design used from a record of past performance in accordance with ACI 301.

B. Submit manufacturer’s certification of meeting these specifications for materials proposed including names, sources, descriptions, and warranties for cement, fly-ash, grouts, water reducing admixtures, epoxy bonding materials, and curing compounds.

C. Submit a sample ready-mixed concrete delivery ticket.

1.03 STORAGE OF MATERIALS

A. Maintain a continuous clean environment and in manner required to maintain homogeneity.

B. Cements, grouts, and mortar shall be containerized and kept in dry humidity environment. Engineer shall reject materials, which have hardened or show any evidence of initial hydration.

1.04 PRODUCT WARRANTY

A. The material manufacturer's standard warranty shall not contain any disclaimer limiting their responsibility to just the purchase price of the material. The manufacturer shall be willing to participate with the Contractor in replacing or repairing any area found to be defective due to faulty materials as determined by accepted test methods.

B. The technical data sheet of the manufacturer shall not have any statement of warranty that would be more limited than this warranty or contain any disclaimer.

PART 2 - PRODUCTS

2.01 CONCRETE

A. ASTM C 94 and mix design approved by Engineer.

B. Strength:

1. Schedule (except as noted):

Type of Structure	Minimum Compressive Strength	Maximum Water/Cement Ratio
Tremie Concrete (see spec. section below)	4,000 psi at 28 days	0.45
All Structures and slabs	4,000 psi at 28 days	0.45
Duct bank or pipe encasement	2,500 psi at 28 days	0.50, per supplier mix design

2. Cementitious content for 4,000 psi concrete shall not be less than 520 pounds per cubic yard of concrete.

3. Entrained air 5-1/2 plus or minus 1 percent.

4. Maximum slump 3 inches; 4 inches for walls (without use of water-reducing admixtures). Where water-reducing admixtures are required to increase workability necessary to facilitate placement of low water, cement ratio concretes, slump range may be 6 to 11 inches in strict accordance with manufacturer's recommendations.

C. Cement ASTM C 150: Type I or Type II for all structures.

D. Aggregates:

1. For concrete 12 inches thick or less, maximum aggregate size 3/4 inch conforming to ASTM C 33, grading No. 67.

2. For concrete over 12 inches thick, maximum aggregate size 1-1/2 inch, conforming to ASTM C 33, grading No. 467.

3. Maximum wear 50 percent at 500 revolutions, AASHTO 96.

E. Water: Clear, free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances.

F. Admixtures:

1. Shall be subject to approval of the Engineer:

a. General:

1) Use only those specified in approved mix design.

2) Apply in strict accordance with manufacturer's printed instructions.

3) No chloride contents permitted.

4) Must be compatible with other admixtures.

2. Air-Entraining Agent: Air entrainment admixtures shall conform to ASTM C 260.

3. Water-Reducing Admixture: Water-reducing admixture shall be Eucon WR-75 by Euclid Chemical, Polyhead by BASF, or Plastocrete 161 by Sika, or approved equal, conforming to ASTM C 494, Type A.

4. High-Range Water-Reducing Admixture: High-range water-reducing admixture (superplasticizer) shall be Rheobuild 1000 by BASF, Eucon-37 by Euclid, BASF Super P, or Sikament by Sika, or approved equal, conforming to ASTM C 494, Type F.

5. Accelerating Admixture: Accelerating admixture, when used, shall be Accelguard 80 by Euclid, Darex Set Accelerator by W.R. Grace, or Pozzutec 20 by BASF or approved equal. The admixture shall conform to ASTM C 494, Type E.

6. Retarding Admixture: Retarding admixture, when used, shall be Eucon Retarder-75 by Euclid, Pozzolith 100-XR by BASF, or Plastocrete 161R by Sika, or approved equal, conforming to ASTM C 494, Type D.

2.02 TREMIE CONCRETE

A. For hydrostatic foundation seals under deep excavations including pump wells that will be placed below water table.

B. Conform the specifications contained in M 41-10 *Standard Specifications for Road, Bridge, and Municipal Construction*, sections 6-02.3(6)B and C. Mix design shall conform to Class 4000W.

2.03 GROUT

A. For equipment, beam bearings and column bases use non-shrink, non-straining, premixed grout, Masterflow 928 by BASF, or approved equal. Apply in accordance with the manufacturer's recommendations.

B. For Anchoring Dowels and Reinforcing Bars: Epoxy grout shall be medium viscosity epoxy conforming to ASTM C 881 Types I, II, III, Classes B and C. Epoxy grout shall be Burke 881 LPL epoxies, or Sikadur 31 Hi-Mod Gel by Sika Corporation, or Concresive paste LPL by BASF, or approved equal. Application shall be per the manufacturer's recommendations.

C. For Fill (Manhole or Basin Bottom Fill): 400 pounds of cement, 120 pounds of fly ash per cubic yard of concrete, 3/8-inch-maximum aggregate, W/C = 0.45.

D. Lean Concrete: 100 pounds of cement, 300 pounds of fly ash per cubic yard of concrete, W/C = 0.50.

E. Flowable Backfill (CDF): 140 pounds of cement per cubic yard of concrete.

2.04 CURING MATERIALS

A. Polyethylene Sheeting: 0.004-inch thick.

B. Waterproof Paper: Polyethylene-coated, Federal Specification UU-B-790 Type I, Grades A, B, C, Style 4. Define lap control lines clearly by printed markings.

C. Membrane Forming Compound: Meet the requirements of ASTM C 309-11.

2.05 BONDING AGENT

A. Epoxy Adhesive Bonding Agent: A two-component compound, 100 percent solids, 100 percent reactive compound suitable for use on dry or damp surfaces. Provide manufacturer's specific

instructions for application. Concresive Liquid (LPL) by BASF, or Sikadur 32 Hi Mod LPL by Sika, or approved equal.

2.06 HOT WEATHER FINISHING AID

A. Evaporation retardant used to retard rapid evaporation of water from exposed concrete. “Confilm” by BASF, EVAPRE by W. R. Meadows, Eucobar by Euclid Chemical, or approved equal.

PART 3 - EXECUTION

3.01 MIXING AND TRANSPORTATION

A. Ready-Mixed Concrete: Conform to ASTM C 94 Alternate No. 3.

3.02 PLACING

A. Deliver only in sufficient quantities required for specified time interval use and placement. Discard concrete having initial set before placement. No remixing with water or supplementing with other materials will be permitted once initial set has occurred. Initial set as evidenced by typical hydration characteristics to be determined by Engineer.

B. Place as nearly as possible to final position to avoid segregation of the materials and displacement of reinforcement. Placement shall be completed within 30 minutes after water is first added to the mix. However, at the Engineer’s discretion if climatic and temperature conditions are suitable and when the concrete is continually agitated, the time may be extended to 1-1/2 hours.

C. Do not change consistency (slump) for a given placement without the Engineer’s written permission.

D. Keep open trough and chutes of steel or steel lined clean and free from coatings of hardened concrete.

E. Do not drop concrete a distance of more than 4 feet or through a cage of reinforcing steel unless concrete is designed flowable with the specified superplasticizer included in the mix, then concrete can free fall up to 10 feet.

F. Do not place concrete in horizontal members or sections until the concrete in the supporting vertical members or sections has been consolidated and a 2-hour period has elapsed since placement in the vertical member to permit shrinkage to occur.

G. In walls containing door and window openings, hold-up placements at the top and bottom of the openings. Stop other placements at levels to conform to drawing details.

H. Layout and sequence of placing of concrete in monolithic structures as shown on the Drawings or approved by the Engineer.

I. Within a placement, deposit concrete in horizontal layers not to exceed 24 inches in depth. Place at rate such that:

1. No concrete surface shall obtain initial set before additional concrete is placed on it.

2. Yielding of forms is not so great as to cause the concrete surfaces to exceed the tolerances specified.

J. Unless specified otherwise, place all slabs and finished floors to finish elevation in one continuous operation, except that the Contractor may place a separate finish topping if prior approval is received from the Engineer. Floor and roof slab sectional thicknesses shown are

minimum thicknesses. Slopes on floors or roofs increase, rather than decrease, slab thicknesses.

K. Construction Joints:

1. Limit size of each slab or wall pour as shown on the Drawings, or as approved by the Engineer, or as follows:

   a. Where construction or control joints are shown to be at 60 feet or less, intermediate construction joints will not be required.

   b. Where construction or control joints are not shown, construction joint spacing shall not exceed 40 feet.

2. Locate construction joints so as not to impair the strength of the structure, and only at locations shown on the Shop Drawings or approved by the Engineer.

3. Construct bulkheads to neatly fit reinforcement and water stops and prevent concrete leakage.

4. Provide water stops or sealants in construction joints where required.

5. Continue reinforcement through construction joint unless otherwise shown or noted.

6. When noted, alternate pour at each side of construction joints with specified minimum curing time between pours.

7. Before placing concrete against previously placed concrete, thoroughly roughen and clean by wet sandblasting or green cutting with an air-water jet:

   a. Use air-water cutting at the proper time after the initial set. Use a high-pressure air-water jet to expose clean, sound aggregate without undercutting the edges of the larger aggregate. Protect adjacent subgrade when cutting is used on slab edges.

   b. After cutting or sandblasting, rinse the surface until wash water contains no cloudiness. Dispose of wastes from cutting, washing, and rinsing so wastes do not stain or abrade exposed surfaces.

8. Place concrete continuously to a predetermined construction joint.

L. Care shall be taken in placing concrete through reinforcements so that no segregation of the coarse aggregate occurs. In any placement where segregation may occur, the concrete shall be designed flowable and placed at 6 inches plus slump. Vibrators shall be inserted no farther than 3 feet from the point of placement of concrete into forms, as concrete is being placed.

M. Special care shall be taken to prevent splashing forms or reinforcement with concrete. Any hardened concrete or partially hardened concrete on the forms or reinforcements above the level of the concrete already in place shall be removed before proceeding with the work.

N. Cold Weather Placement:

1. Concrete shall be placed only when the temperature is at least 40 degrees F, and rising, unless permission to pour is obtained from the Engineer.

2. Material shall be heated and otherwise prepared so that batching and mixing can proceed in full accord with the provisions of this specification.

3. Suitable means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for a period of at least the first 5 days and at a temperature above freezing for the remainder of the specified curing period, except that where high-early-strength

cement is used, this period may be reduced to 72 hours. The methods proposed for heating the materials and protecting the concrete shall be approved by the Engineer.

4. Salts, chemicals, or other materials shall not be mixed with concrete for the purpose of preventing freezing. Accelerating agent shall be a non-chloride-based admixture conforming to ASTM C 494 requirements, applied per the manufacturer's recommendations.

O. Hot Weather Placement:

1. The temperature of fresh concrete at the time of placement during hot weather shall be a maximum of 90 degrees F, to prevent an accelerated setting of the concrete.

2. A retarding densifier admixture shall be used when the high expected atmospheric temperature for the day is 85 degrees F or above. Admixture shall be used in accordance with the manufacturer's recommendations.

P. Placing Concrete Against Earth:

1. Unless otherwise called for on the Drawings, earth cuts shall not be used as forms for vertical surfaces without the prior approval of the Engineer.

2. Concrete placed on or against earth shall be placed only upon or against firm, damp surfaces free from frost, ice, and standing or running water. Concrete shall not be placed upon mud or upon fills until the required compaction has been obtained.

3.03 COMPACTING

A. Compact all concrete with high-frequency internal vibrators immediately after placing.

B. Use external vibrators for compacting concrete where the concrete is inaccessible for adequate compaction by internal vibrators; construct forms sufficiently rigid to resist displacement or damage from external vibration.

C. Use mechanical vibrating equipment, always keeping the vibrator within 3 feet of the discharge point into the form. For exposed concrete surfaces and architectural concrete, keep the vibrator on the unexposed side of the reinforcing steel or at least 2-1/2 inches from the form surface. Vibrate the concrete as the concrete is being placed to prevent honeycomb, rock pockets, and voids. Do not insert vibrators into lower layers of concrete that have begun to set. Vibration required on flowable concrete is about one-fourth that needed for 4-inch-slump concrete.

3.04 CURING AND PROTECTION

A. General:

1. Maintain at site, ready to install, before actual concrete placing begins, all equipment and materials needed for optimum concrete curing and protection; maintain extra vibrators on standby in case of malfunction of any unit.

2. Protect finished surfaces or edges from stains, abrasions, and breakage during the entire construction period.

3. Protect all concrete from accelerated drying and excessive heat at all times. Close all conduits and other formed openings through the concrete during the entire curing period and as long thereafter as practicable to prevent drying of concrete by air circulation.

4. Install slab-curing covers immediately after initial set or as soon as free water has disappeared from the surface of the concrete after finishing or surfacing.

B. Water Curing (use water curing specified herein for all walls and slabs where watertight construction is required):

1. Keep continuously wet by covering with an approved material or by a system of perforated pipes or mechanical sprinklers or other approved methods.

2. Keep forms wet at all times to prevent opening of joints and the drying out of the concrete.

3. Water for curing shall be clean and free from any elements, which might cause objectionable staining or discoloration of the concrete.

4. Cover surfaces completely with sheeting. Where a single sheet does not cover the entire surface, lap ends and edges at least 4 inches, and continuously seal with tape or other suitable means recommended by the manufacturer.

5. Continue waterproof sheet curing for 7 days. Maintain sheeting and edge and end seals intact for entire period. Repair immediately any breaks in the sheeting envelope.

C. Curing Compounds (use only when specifically approved and for optimum climatic conditions):

1. Do not use curing compounds unless this use is authorized in writing by the Engineer. Curing compounds are unacceptable where concrete is exposed to the direct rays of the sun or in accelerated drying conditions.

2. All interior slabs shall have membrane-forming compounds that meet the moisture retention required by ASTM C 309-81 when applied at a normal single coat.

3. Prior to applying curing compounds to formed surfaces, the surfaces shall be moistened with a spray of water immediately after forms are removed. Moistening shall be continued until the surfaces will not readily absorb more water. The compound shall be applied as soon as the moisture film has disappeared and while the surface is still damp.

4. On slabs, the compounds shall be applied immediately after finishing and after bleeding water and “shine” has disappeared.

5. Curing compounds shall not be used on surfaces where future bonding, painting, or protective coating is required. In cold weather, curing compounds shall not be used on concrete surfaces, which are kept at curing temperature, by the use of steam.

3.05 REPAIRING CONCRETE

A. Immediately after removal of forms, break back all form ties and inspect concrete surfaces for defects. Complete repair of defects within 48 hours after removal of forms. No repairs shall be made until the defects have been reviewed and method of repair approved by the Engineer.

B. Remove all defective or damaged concrete, including honeycombed, sand streaked, or fractured material from the area to be repaired. Chip out areas to 1-inch-minimum depth. Edge shall be squared with the surface to eliminate feather edges.

C. Before placing the repair material, obtain Engineer inspection. Clean area free of chipping dust, dried mortar, and all other foreign material.

D. Keep surfaces to be repaired continuously wet for at least 3 hours prior to placing new concrete or mortar. No free water on the surface when the repair material is placed.

E. Apply a bonding agent to the area to be repaired before placing repair material. Apply the bonding agent per manufacturer’s published instructions attached to container.

F. For all repair surfaces permanently exposed to atmosphere use white cement in proportions found by trial to be effective in producing a color which, in the hardened patch, will match the surrounding concrete surface.

G. Make repairs by: (1) dry-packing, (2) filling with concrete, or (3) plastering with mortar or a combination of all three in conformance with the following:

1. Use the dry-pack method for holes at least 1 inch deep where the depth is equal to, or greater than the smallest surface dimension of the defect, such as cone-bolt or form tie holes, and for narrow slots cut for the repair of cracks. Do not use the dry-pack method where lateral restraint cannot be obtained. Place and pack dry-pack mortar in layers having a compacted thickness of approximately 3/8 inch. Solidly compact each layer over its entire surface by use of a hardwood stick and hammer. Do not use metal tools for compacting. Compact surface just flush with adjacent area. Do not use steel finishing tools or water to facilitate finishing. Color match.

2. Use concrete replacement for (1) holes extending entirely through concrete sections; (2) for holes larger than 1 square foot and deeper than 4 inches in which no reinforcement is encountered; (3) for holes larger than 1/2 of 1 square foot where reinforcement is exposed. Concrete used for replacement shall be of the same strength and mixture as used in the structure. Color match.

3. Use mortar replacement for holes too wide to dry-pack and too shallow for concrete replacement and when approved by the Engineer for other conditions not covered by Items (1) and (2) above.

H. Cure all repairs with the same methods as new concrete.

3.06 CONCRETE FINISHES AND TOLERANCE

A. Schedule of Concrete Finishes:

1. Area and Type:

a. Walls:

1) Exterior Below Grade and Tank Interior: W-1.

2) Exposed Interior and Exterior: W-2.

b. Slabs:

1) Interior: S-1.

2) Roof Covered, Top of Isolated Footings, and Base Slabs: S-2.

3) Tank Floors: S-2.

4) Exterior and Top of Walls: S-3.

B. Concrete Wall Finish:

1. Type W-1:

a. Fill snap-tie holes with nonshrink, nonmetallic grout.

b. Knock off projections.

c. Patch honeycomb areas and rock pockets. Small air holes do not require patching.

2. Type W-2 - Sacked Wall Finish:

a. Fill snap-tie holes with approved nonshrink, nonmetallic color match grout.

b. Grind off projections, fins, and rough spots.

c. Sack surface to fill all voids and pinholes in accordance with ACI 301, Section 10.3.2.

C. Concrete Slab Finishes:

1. General:

a. Do not excessively use “jitterbugs” or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar to accumulate.

b. Do not dust surfaces with dry materials, except where floor hardener is to be applied.

c. Thoroughly compact slabs and floors by vibration.

d. Round off all edges of slabs and tops of walls with a steel-edging tool, except where a cove finish is shown. Steel edging tool radius shall be 1/4 inch for all slabs subject to wheeled traffic.

e. After applying the final floor finish and after curing cover slabs with Visqueen or other material, keep floor clean and protect it from material and damage due to other construction work.

2. Type S-1 - Concrete Slab Finish Steel Troweled Finish:

a. Finish by screeding and floating with straight edges to bring surfaces to required finish elevation shown.

b. While concrete is still green, but sufficiently hardened to bear a person’s weight without deep imprint, float to true, even plane with no coarse aggregate visible.

c. Use sufficient pressure on floats to bring moisture to surface.

d. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.

e. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.

f. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.

g. Power Finishing:

1) An approved power machine may be used in lieu of hand finishing for finishing concrete floors and slabs in accordance with directions of machine manufacturer.

2) Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.

3) Do first steel troweling for slab S-1 finish by hand.

3. Type S-2 - Slab Finish Float:

a. Finish slabs to receive fill and mortar setting beds by screeding with straight edges to bring surface to required finish plane.

b. Float slab to compact and seal surface.

c. Remove all laitance and leave surface clean.

d. Coordinate with other finish procedures.

D. Tolerances:

1. Unless otherwise required, allowable tolerances for concrete surfaces shall be in accordance with those shown in the table below. Surface irregularities are classified as either “abrupt” or “gradual.” Offsets caused by displaced or misplaced form sheathing, lining, or form section or by defective form lumber shall be considered as abrupt irregularities. All others are classed as gradual irregularities. Gradual irregularities shall be measured with a template consisting of a straight edge for plane surfaces and its equivalent for curved surfaces.

2. The length of the template for testing formed surfaces is 5 feet. The length of the template for unformed surfaces is 10 feet. Maintain a 5-foot-long and a 10-foot-long steel template on the job site.

3. Maximum Allowable Irregularities in Concrete:

	Irregularity in Inches	
Location	Gradual	Abrupt
Walls	1/4	3/16
Slabs	1/4	1/4

3.07 UNSATISFACTORY CONCRETE

A. Any concrete placed which fails to meet or exceed the specified strength requirements as determined from molded cylinders, or cores, or to meet the density or surface requirements, or which has been frozen during placing or curing, shall be removed and replaced with satisfactory materials at the Contractor’s expense.

B. Method of Determining Unsatisfactory Concrete: Visual appearance characteristic of rain or freeze damage to concrete which is apparent to the Engineer.

3.08 BONDING TO OLD CONCRETE

A. Clean existing concrete surfaces by using wet sandblast or ultra-high pressure water jet to remove the surface film and contaminants. Roughen to 1/4-inch amplitude or as shown on the Drawings. Coat the contact surfaces with bonding agent specified in paragraph 2.4. Apply the bonding agent in conformance with the manufacturer’s instruction. As concrete is placed, thoroughly vibrate against the contact overface. Concrete at the contact surface should be revibrated deeply as late as the running vibrator will penetrate the concrete of its own weight.

3.09 HOUSEKEEPING

A. No wash-down water or waste concrete shall be allowed into the stormwater system. Use Owner approved environmental controls to contain waste and wastewater. Dispose of such materials off-site in an approved manner.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies non-shrink grout and epoxy grout for use in applications including but not limited to grouts for leveling machine bases to equipment pads and grouting under base plates. Epoxy adhesives for concrete applications not included in Section 03 15 19 such as pressure injection of cracks and doweling of anchor bolts, threaded rod anchors and reinforcing bar dowels.

1.02 QUALITY CONTROL

A. Referenced Standards: This section incorporates by reference the latest revision of the following documents. These references 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
ASTM C 33	Concrete Aggregates
ASTM C 40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 88	Test Method for Soundness of Aggregates by Use of
ASTM C 117	Test Method for Materials Finer than No. 200 Sieve in
ASTM C 136	Test Method for Sieve Analysis of Fine and Course
ASTM C 150	Portland Cement
ASTM C 289	Test Method for Potential Alkali-Silica Reactivity of
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 881	Standard for Epoxy-Resin-Base Bonding Systems for
ASTM C 1017	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine
ASTM E 329	Standard Specification for Agencies Engaged in the Testing
CRD-C-621	Corps of Engineers Specification for Non-Shrink Grout

1.03 SUBMITTALS

A. Manufacturer’s Data for the following:

1. Non-shrink cementitious grout.
2. Epoxy grout.
3. Admixtures for cement grout.
4. Adhesive for doweling.
5. Bonding compounds.

PART 2 - PRODUCTS

2.01 GENERAL

A. Grout mixes and admixtures shall not contain more than 0.05 percent chloride ions.

B. Water for washing aggregate, for mixing, and for curing:

1. Shall be free from oil and deleterious amounts of acids, alkalis, and organic materials
2. Shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L of sulfates as SO4.
3. Shall not contain an amount of impurities that may cause a change of more than 25 percent in the setting time of the cement nor a reduction of more than 5 percent in the compressive strength of the grout at 14 days when compared with the result obtained with distilled water.
4. Water used for curing shall not contain an amount of impurities sufficient to discolor the grout.

2.02 GROUT

A. Use grout specified on the Contract Drawings or as specified in the equipment recommendations.

B. Non-shrink cementitious grout:

1. Cementitious grout that conforms to ASTM C 1107, CRD-C-621, “Corps of Engineers Specification for Non-Shrink Grout”, and the following requirements:
   a. Non-metallic aggregate.
   b. Acceptable manufacturers:
      1) Euclid Chemical Co., “Euco NS”.
      2) BASF, “Masterflow 713 Plus”.
      3) Five Star Grout Co., “Five-Star Grout”.
      4) Or approved equal.

C. Epoxy Grout:

1. Multi-component, 100 percent solids compound conforming to the following requirements:
   a. Suitable for use on dry or damp surfaces.
   b. Comply with ASTM C 881.
   c. Acceptable manufacturer:
      1) Euclid Chemical Co., “DuralBond”.
      2) Sika Chemical Co, “Sikadur 35 Hi-Mod LV”.
      3) BASF, “SCB Concresive 1380”.
      4) Or approved equal.

2.03 ADHESIVES

A. Adhesive for doweling of anchors and reinforcing bars in concrete:

1. A two-component, moisture tolerant, epoxy gel conforming to ASTM C 881 for load bearing applications.
2. Acceptable manufacturers:
    a. Euclid Chemical Co., “Euco #452”.
    b. Sika Corporation, “Sikadur Anchor Fix-4”.
    c. Simpson Strong Tie, “Set XP”.
    d. Hilti, “HIT RE 500SD”.
    e. BASF, “SCB Concresive 1380”.
    f. Or approved Equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Mix, place and cure in accordance with the manufacturer’s instructions.

B. For grouting of equipment base plates, refer to manufacturer’s instructions for appropriate procedures.

3.02 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that these surfaces are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and all loose material or foreign matter likely to affect the bond or performance of grout or mortar.

B. Inspect base plate and anchor systems for rust, oil, and other deleterious substances that may affect the bond or performance of grout.

C. Confirm that newly placed concrete has been cured sufficiently to attain its design strength and limit further shrinkage.

D. Verify that temperature of cementitious or epoxy grout does not exceed manufacturer’s recommendations.

3.03 PREPARATION

A. Surface Preparation:

1. Roughen all concrete surfaces by chipping, or other mechanical means to assure bond. Loose or broken concrete shall be removed.
2. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials that may affect bond that were identified in the inspection process shall be completely removed from concrete and bottoms of base plates. All metal surfaces should have a 2 to 3 mil peak-to-valley profile for epoxy grouts.
3. For cementitious mortars and grouts, concrete shall be saturated surface damp. Any standing water shall be removed prior to placing grouts.
4. For epoxy grouts, do not wet concrete surfaces with water. Instead, where required, wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grouts.

B. Forms and Headboxes for Cementitious or Epoxy Grouts:

1. Forms for grouts shall be built of material with adequate strength to withstand the placement of grouts.
2. Forms must be rigid and liquid tight. All cracks and joints shall be caulked with an elastomeric sealant. All forms shall be lined with polyethylene for easy grout release. Forms carefully waxed with two coats of heavy-duty paste wax shall also be acceptable.
3. Forms shall be 4 to 6 inches higher than the base plate on one side of the base plate configuration when using head pressure for placement.
4. Air relief holes a minimum 1/8 inch in diameter shall be provided when required by a base plate configuration to avoid entrapping air underneath.

3.04 NON-SHRINK CEMENTITIOUS GROUT

A. Prepare concrete surfaces in accordance with the grout manufacturer's instructions.

B. Do not retemper grout by adding more water after stiffening.

3.05 EPOXY GROUT

A. Prime concrete in accordance with the grout manufacturer's instructions.

B. Epoxy grouts shall be mixed in complete units. Do not vary the ratio of components or add solvent to change the consistency of the mix.

C. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in the mix.

3.06 DOWEL INSTALLATION

A. Install per adhesive manufacturer's instructions.

B. Obstructions in Drill Path.

1. Locate holes in existing concrete to miss existing reinforcing. Prior to drilling holes, field verify and mark the location of existing reinforcing using a pachometer or other approved locating equipment.
2. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction. Drill shall not be slanted more than 10 degrees. Where slanting the drill does not resolve the conflict, the Contractor shall stop and notify the Project Representative and resolve the conflict to the satisfaction of the Project Representative.
3. Abandoned dowel or anchor holes shall be completely filled with non-shrink grout and struck off flush with the adjacent surface.

3.07 CURING

A. Cementitious Grouts:

1. Clean equipment and tools as recommended by the grout manufacturer.
2. Cure Grouts in accordance with manufacturer's specifications and recommendations. Keep grout moist for a minimum of 3 days. The method needed to protect grouts will depend on temperature, humidity, and wind. Wet burlap, a soaker hose, sun shading, ponding, and, in extreme conditions, a combination of methods shall be employed.
3. Grouts shall be maintained above 40 degrees Fahrenheit until the grout has attained a compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for a minimum of 24 hours to avoid damage from subsequent freezing.

B. Epoxy Grouts:

1. Cure grouts in accordance with manufacturers' specifications and recommendations. Do not wet cure epoxy grouts.
2. Consult the manufacturer for appropriate cure schedule. In no case should any surface in contact with epoxy grout be allowed to fall below 50 degrees Fahrenheit for a minimum of 48 hours after placement.

3.08 INSPECTION AND TESTING

A. Installation of epoxy anchors shall take place under continuous supervision of the Special Inspector, who shall verify hole depth, diameter and cleaning; proper mixing and application of the epoxy materials; and installation of the fastener embedments to the proper depths.

B. During the course of construction, the Project Representative may take separate field samples of the following materials for confirming tests:

1. Cement.
2. Aggregates.
3. Cement grout mixture.
4. Commercially manufactured grout products.

C. The testing laboratory will sample and test grout materials and submit results to the Project Representative.

END OF SECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Materials, Fabrication, and Erection: Conform to the latest edition of AISC *Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings*.

B. Welding: By operators qualified by tests as prescribed by the AWS in Standard Qualification Procedure for performance of the type of work required. Structural welding shall be performed by welders certified by ICBO or local building department jurisdiction.

1.02 SUBMITTAL

A. Shop Drawings: All fabricated metals illustrating dimensions, erection details, cuts, copes, connections, holes, threaded fasteners, and welds. Base dimensional data on actual field measurements where connections interface with other materials required.

B. Mill Test Reports: Submit mill test reports for each shipment of materials or products.

1.03 PRODUCT HANDLING

A. Delivery of Materials Installed Under Other Sections:

1. Deliver anchor bolts, anchorage devices, sleeves, and other steel to be embedded in cast-in-place concrete or masonry prior to start of concrete or masonry work.

2. Provide setting drawings, templates, and direction for installation of anchor bolts and other devices.

B. Store above grade. Protect from corrosive elements.

C. Handle and store during construction to prevent overstressing any elements.

PART 2 -PRODUCTS

2.01 MATERIALS

A. Structural Steel - All new material, clean and free from damage:

1. Rolled Shapes: ASTM A 992.

2. American Standard Shapes, Channels, Angles, Bars, and Plates: ASTM A 36.

3. Steel pipe: ASTM A 53 Grade B.

4. Tubes (HSS): ASTM A 500 Grade B or C.

B. Bolts:

1. Standard Bolts and Nuts: ASTM A 307.

2. High Strength Bolts and Nuts: ASTM A 325 N.

3. Anchor Bolts: ASTM F 1554 Grade 36, or ASTM A 307.

4. Bolts used for blind fastening of hollow structural shapes shall be as manufactured by Lindapter International, Blind Bolt Company, or approved equal. Bolts shall be hex-headed and hot dip galvanized.

C. Welded Studs: TRW Nelson, Elrod Stud Welding, Keystone Fastening Technologies or approved equal headed anchor studs.

D. Welding Electrodes: AWS E70XX.

E. Shop Paint Primer: Prime assembled steel compatible with finish specified.

2.02 FABRICATION

A. Fabricate structural and architectural steel in accordance with the appropriate AISC Specifications with the modifications and additional requirements specified in this section.

B. Weld all shop connections unless otherwise noted:

1. Conform to AWS Code for “Arc Welding in Building Construction.”

2. Remove all weld spatter from exposed surfaces.

C. Straightness of Structural Members: Straightness of structural members and fabricated assemblies shall conform to AISC Specification.

D. Shop Assembly:

1. Fabricate units in as large parts and sections as practicable.

2. Holes in members: Punch or drill as necessary to receive bolts and similar items. Do not cut holes with a torch.

3. Provide holes as required for venting closed members that are to be galvanized.

PART 3 - EXECUTION

3.01 ERECTION

A. Set and secure structural steel members and appurtenant connections accurately to the required lines and levels shown on drawings.

B. All procedures and tolerances per AISC Standards and Specifications.

C. Bolts, Anchors and Other Accessories: Install as necessary and as required for erection of structural steel.

D. Bearing Plates:

1. Provide under all steel, such as ends of beams bearing on concrete.

2. Shim with metal only.

E. Columns:

1. Set on leveling nuts or on metal shims to accurate elevations and grout solid.

2. Shim with metal only. Do not use wood wedges.

F. Anchor Bolts and Anchors: Locate and build into connecting work. Preset anchor bolts and anchors using templates of configuration required for fastening to structural members.

G. Grouting: After all structural members have been properly positioned and all bolts and anchor bolts tightened, place grout between concrete and steel. Finish exposed surfaces or grout flush and smooth.

END OF SECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Materials, Fabrication, and Erection: Conform to the latest edition of AISC “Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings” (steel assemblies) and the Aluminum Association’s Aluminum Construction Manual (aluminum assemblies).

B. Welding: By operators qualified by tests as prescribed by the AWS in “Standard Qualification Procedure” for performance of the type of work required. Structural welding will require all welders to be certified by ICBO or local building department jurisdiction.

C. Comply with OSHA/WISHA and Building Code requirements.

1.02 SUBMITTALS

A. Shop Drawings: All fabricated metals illustrating dimensions, erection details, cuts, copes, connections, holes, threaded fasteners, and welds. Base dimensional data on actual field measurements where connections interface with other materials required.

B. Mill Test Reports: Submit mill test reports for each shipment of materials or products.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in such a manner as to prevent damage to finished surfaces.

B. Store above grade in clean and dry locations. Protect from corrosive elements.

PART 2 - PRODUCTS

2.01 STRUCTURAL STEEL

A. Conform to Section 05 12 20 - Structural Steel.

B. All structural steel that is not embedded in concrete shall be galvanized unless otherwise specified. Exposed galvanized structural steel shall be painted in accordance with Section 09 90 00 - Equipment and Piping Painting.

C. Bolts: As specified in Section 05 12 20 - Structural Steel, hot dip galvanized.

2.02 STAINLESS STEEL

A. Bars and Shapes: ASTM A 276, Type 304.

B. Plates: ASTM A 240, Type 304.

C. Bolts: ASTM A 193, Type 316.

D. Nuts: ASTM A 194, Type 316.

2.03 PIPE RAILING

A. Posts and rails shall be fabricated of aluminum, designed to meet the load requirements of International Building Code Section 1607.8, with fittings attached with Allen head screws.

1. Railing shall be as manufactured by Kee Safety - “Speed Rail”.
2. Golden Railings.
3. Or approved equal.

B. All connections shall be mechanically joined using special connection pieces fabricated specifically for this use.

C. Pipe rails (used as “guards” as defined in the IBC) shall be provided as shown along platform edges. The top of the top rail shall be a minimum of 42 inches and a maximum of 44 inches above the walking surface. The railing configuration shall consist of a top rail and two (2) intermediate rails, equally spaced.

D. Maximum spacing of posts shall be 6 feet.

E. Toe boards consisting of a 1/4-inch-thick by 4-inch-high plate or extrusion shall be provided on all exposed sides of all floor openings above occupied space and where indicated on the Drawings. Not more than 1/4-inch clearance shall be permitted between toe board and floor level.

F. At openings in handrail, provide OSHA/WISHA approved safety gates or safety chains, as shown on the Drawings.

G. Painting: Railings shall be painted “Safety Yellow” in accordance with Section 09 90 00 - Equipment and Piping Painting.

2.04 FLOOR PLATE

A. Floor and cover plates shall be checkered (diamond tread) plate, material and thicknesses as noted.

PART 3 - EXECUTION

3.01 FABRICATION

A. Fabricate in accordance with the Drawings and additional requirements specified in this section.

B. Shop Assembly:

1. Fabricate units in as large parts and sections as practicable.

2. Holes in Members: Punch or drill as necessary to receive bolts and similar items. Do not cut holes with a torch.

3. Close all ends of pipe railing or hand rail with post terminal or cap with hemispherical caps of approved design.

C. Galvanize all carbon steel bolts, fastenings, and hardware unless otherwise noted.

3.02 ERECTION

A. Set and secure accurately to the required lines and levels.

B. Protect the finish from scratches, nicks, and dents during erection.

C. Handrail: Install true to line and grade. Remove all burrs at cut ends of rail.

D. Repairing galvanizing as specified in Section 05 51 16 - Galvanizing.

E. Painting as specified in Section 09 90 00 - Equipment and Piping Painting.

F. Anchor Bolts and Anchors: Locate and build into connecting work. Preset anchor bolts and anchors attached to templates of configuration required for fastening to structural members.

G. Grouting: After all structural members have been properly positioned and all bolts and anchor bolts tightened, place grout between concrete and metal. Finish exposed surfaces flush and smooth.

END OF SECTION

PART 1 - GENERAL

1.01 DEFINITIONS

A. Hot-Dip Galvanizing: The dipping of steel members and assemblies into molten zinc for lasting (or long-term) corrosion protection. The resultant zinc coating fuses permanently with the base steel material.

B. Passivating: The mechanical treatment of freshly galvanized steel materials to prevent humid storage stain (white rust or white corrosion). This treatment (passivation) consists of quenching freshly galvanized steel in water to which a chromate or a chromic-acid solution, or other proprietary solution, has been added.

1.02 QUALITY ASSURANCE

A. Reference Standards: American Hot-Dip Galvanizers Association, Inc. (AHDGA): Publication, “Inspection Manual for Hot-Dip Galvanized Products.”

B. Certification: Furnish Certificates of Compliance with ASTM Specifications, and Standards specified herein. Each certificate to be signed by Contractor and galvanizer certifying that steel materials, bolts, nuts, washers, and items of iron and steel hardware conform to specified requirements.

1.03 DELIVERY, STORAGE AND HANDLING

A. Packaging: Of type to prevent damage to galvanized surfaces and distortion of steel materials and components.

B. Handling and Storage: Handle and protect galvanized materials from damage to zinc coating. To avoid humid storage stain, space surfaces of galvanized materials to permit free circulation of air.

C. Damaged Material: Repair material showing evidence of damage to zinc coating. If not repairable, material with damaged coating will be subject to rejection.

PART 2 - PRODUCTS

2.01 STEEL MATERIALS

A. Material for galvanizing to be geometrically suitable for galvanizing as specified in ASTM A 384 and A 385. Steel materials suitable for galvanizing include structural shapes, pipe, sheet, fabrications, and assemblies.

B. Material to be chemically suitable for galvanizing.

C. Coordinate with Steel Fabricator to insure adequate vent holes for closed sections. Drawings indicate suggested vent hole locations for appearance and weather tightness considerations. Notify Engineer if these are not compatible with galvanizing processes.

2.02 IRON AND STEEL HARDWARE

A. Bolts, nuts, washers, and items of iron and steel hardware furnished for galvanizing to be suitable for hot-dip galvanizing.

B. Inspect iron and steel hardware before galvanizing and ascertain whether suitable for galvanizing. Replace items that are not suitable for galvanizing.

2.03 ZINC FOR GALVANIZING

A. Conform with ASTM B 6, and as specified in ASTM A 123.

2.04 GALVANIZING

A. Steel members, fabrications, and assemblies to be galvanized after fabrication, by hot-dip process in accordance with ASTM A 123. Weight of zinc coating to conform to requirements specified under “Weight of Coating” in ASTM A 123.

B. Safeguard against steel embrittlement in conformance with ASTM A 123.

C. Safeguard against warpage or distortion of steel members to conform to ASTM A 384. Notify Engineer of potential warpage problems that may require modification in design, before proceeding with steel fabrications.

D. Finish and uniformity of zinc coating and adherence of coating to conform to ASTM A 123, A 153, or A 386, as applicable.

E. Bolts, nuts, and washers, and iron and steel hardware components to be galvanized in accordance with ASTM A 153. Weight of zinc coating to conform to requirements specified under “Weight of Coating” in ASTM A 153. Nuts to be tapped after galvanizing to minimum diametral amounts specified in ASTM A 563. Coat nuts with waterproof lubricant, clean and dry to touch. High strength bolts for structural steel joints to be galvanized in accordance with ASTM A 325.

2.05 PASSIVATING

A. Galvanized materials subject to extended periods of storage in open, exterior locations to be given passivating treatment or light oiling to prevent humid storage stain. Treatment, solution, and process subject to review and acceptance by Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION OF STEEL MATERIALS

A. Steel materials, fabrications, and assemblies are to be installed as shown on the Drawings or specified.

3.02 FIELD INSPECTION

A. Inspect installed galvanized materials, fabrications, and assemblies in accordance with the applicable requirements of AHDGA “Inspection Manual for Hot-Dip Galvanized Products,” for visual inspection.

3.03 TOUCH UP AND REPAIR

A. Repair damaged galvanized surfaces with hot melt repair materials in accordance with ASTM A 780. Galvanizing repair paints will not be accepted.

B. Dry film thickness of applied repair materials to be not less than galvanized coating thickness required by ASTM A 120, A 123, A 153, as applicable.

3.04 PAINTING

A. All exposed galvanized materials must be painted per Specification Section 09 90 00.

END OF SECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE CONTROL

A. Prepare and use in strict accordance with manufacturer's instructions. Discard materials after specified "shelf life."

B. Deliver products in manufacturer labeled containers with complete preprinted instructions by manufacturer included.

C. Installers experienced in use of products.

1.02 SUBMITTALS

A. Sealant type and manufacturer.

B. Premolded composition board and backer rod samples.

C. Certification of conformance to Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fiber expansion board ASTM D 1751.

B. Joint Sealant:

1. Polyurethane material designated for bonding to concrete for sewage treatment plant service, which when cured, develops a high bond between surfaces and provides flexible watertight seal, non-sag, resistant to mild alkalis and acids, oils and meets all requirements for Federal Specifications TT-S-00230C, Type II. Prior to ordering the sealant, submit to the Engineer for review, sufficient data to show experience record of sealant and general compliance with the Specification requirements.

2. Joint primer supplied by the same manufacturer supplying the sealant.

C. Backer-Rod: Closed cell polyethylene backer-rod shall be used in sealant joints. The backer-rod shall be resilient and of a diameter at least 1/8 inch larger than the groove and shall be approved by the sealant manufacturer.

D. Building Paper: No. 15 asphalt felt.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Joints constructed and located as shown on the Drawings.

B. Sealant Surfaces: Clean, free of oil, grease, residue and other foreign materials, prior to application of sealant in accordance with manufacturer's recommendations. Prime all joints with joint primer.

C. Sealant Application:

1. Tape or otherwise protect surfaces adjacent to joints not intended to receive sealants. The backer-rod shall be accurately placed in the joint to provide the depth of sealant called for on the Drawings.

2. Neatly apply sealants to fill void required to level non-sag surface. Maintain uniform application procedures to continuously apply sealant. Complete joint system without intermediate stops and starts.

3. Sealant shall be applied according to manufacturer's recommendations in a manner so as to avoid entrainment of air in the joint.
4. Secure preformed board to surfaces with fasteners and procedures recommended by manufacturer.

END OF SECTION

PART 1 - GENERAL

1.01 WORK SCHEDULED

A. Wet well and valve vault access hatches will be provided as integral to the precast concrete structures provided by the Owner and as shown on the Contract Drawings. Contractor is responsible for installation of these precast structures with integral access hatches and use of access hatches to allow for installation of all system accessories and appurtenances to allow for a complete and fully functional system.

B. Hatches will be provided as integral to cast-in-place concrete vault lids and precast vaults as provided by the Owner.

1.02 GENERAL REQUIREMENTS

A. The units will be single leaf or double leaf as shown.

PART 2 - PRODUCTS

2.01 WET WELL AND VALVE VAULT ACCESS HATCHES

A. The wet well and valve vault hatches will be provided by the Owner and will be cast into the top slabs of the new pump station wet wells. See the Advance Procurement documents for additional information.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate installation of wet well and valve vault provided by the Owner with integral access hatches as shown on the Drawings with the work of other trades.

B. Connect drain from channel frame as indicated.

3.02 ADJUST AND CLEAN

A. Adjust hardware and doors after installation of wet well and valve vault structures for proper operation.

B. Remove and replace hatches or frames that are warped, bowed, or otherwise damaged during installation or startup.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the surface preparation, painting, and finishing of process, mechanical, and electrical equipment specified in Divisions 11 through 28 of the Contract Documents.

B. Painting includes field painting exposed bare and covered pipes, hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.

D. Prefinished items not to be painted include the following factory-finished components, except where color coding is required:

1. Light fixtures.
2. Switchgear.
3. Distribution cabinets.

E. Finished metal surfaces not to be painted include:

1. Anodized aluminum (except handrails, which are to be painted “Safety Yellow”).
2. Stainless steel.

F. Operating parts not to be painted include moving parts of operating equipment such as the following:

1. Valve and damper operators.
2. Linkages.
3. Sensing devices.
4. Motor, pump, and fan shafts.

G. Labels: Do not paint over Underwriter’s Laboratories, Factory Mutual, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.02 SUBMITTALS

A. Data Sheets:

1. For each paint system furnish Material Safety Data Sheets (MSDS), the manufacturer’s Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system.
2. Submit required information on a system-by-system basis.

B. Quality Control Submittals:

1. Applicator’s Qualification: List of references substantiating experience.
2. Factory-Applied Coatings: Manufacturer’s certification stating factory-applied coating system meets or exceeds requirements specified.
3. Manufacturer’s written instructions and special details for applying each type of paint.

1.03 QUALITY ASSURANCE

A. Qualifications - Applicator: Minimum 5 years of experience in application of specified products.

B. Regulatory Requirements: Meet federal, state, and local requirements limiting the emission of volatile organic compounds:

1. Perform surface preparation and painting in accordance with recommendations of the following:

a. Paint manufacturer's instructions.

b. SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.

c. Federal, state, and local agencies having jurisdiction.

C. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the jobsite in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.

2. Product description (generic classification or binder type).

3. Federal specification number, if applicable.

4. Manufacturer's stock number and date of manufacture.

5. Contents by volume, for pigment and vehicle constituents.

6. Thinning instructions.

7. Application instructions.

8. Color name and number.

B. Store materials not in use in tightly covered containers in a well-ventilated area at an ambient temperature greater than the minimum temperature recommended by the manufacturer. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

C. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.05 JOB CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F and 90 degrees F.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F and 95 degrees F.

C. Do not apply paint in snow, rain, fog, or mist when the relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point unless specifically allowed by the manufacturer, or to damp or wet surfaces.

D. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature and humidity limits specified by the manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

1. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:

a. Fuller O'Brien (Fuller).

b. PPG Industries, Pittsburgh Paints (PPG).

c. Tnemec Company, Inc. (Tnemec).

d. Sherwin-Williams (SW).

e. Or approved equal.

2.02 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide primers, finish-coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application as demonstrated by the manufacturer based on testing and field experience.

B. Material Quality: Provide the manufacturer's best-quality trade-sale paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

C. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish the manufacturer's material data and certificates of performance for proposed substitutions.

D. Colors: Provide color selections made by the Engineer from the manufacturer's full range of standard colors.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied:

1. Do not begin to apply paint until unsatisfactory conditions have been corrected.

2. Start of painting will be construed as the applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work:

1. Review other sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

2. Notify the Engineer about anticipated problems using the materials specified over substrates primed by others, or over existing coated surfaces that are to be prepared and recoated.

3.02 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted or provide surface-applied protection prior to surface preparation and painting. Remove these items, if necessary, to completely paint the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation:

1. Clean and prepare surfaces to be painted according to the manufacturer's instructions for each particular substrate condition and as specified.

2. Provide barrier coats over incompatible primers and existing coatings or remove and redo. Notify Engineer in writing about anticipated problems using the specified finish-coat material with substrates primed by others.

3. Ferrous Metals:

   a. Clean ungalvanized ferrous-metal surfaces that have not been shop-coated and previously painted metals indicated for painting; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council (SSPC).

   b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

4. Galvanized Surfaces:

   a. Clean galvanized surfaces with nonpetroleum-based solvents so that the surface is free of oil and surface contaminants.

   b. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

5. PVC Pipe:

   a. Prepare PVC surfaces in accordance with manufacturer's instructions. All PVC pipe exposed to sunlight shall be painted.

   b. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

   c. Scarify PVC surfaces.

   d. Painting of MH and CLS pipe not required.

6. Ductile Iron Pipe:

   a. Prepare ductile or cast iron surfaces in accordance with manufacturers' instructions.

   b. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants. Provide solvent cleaning per National Association of Pipe Fabricators Standard NAPF 500-03-01.

D. Materials Preparation:

1. Carefully mix and prepare paint materials according to manufacturer's directions.
2. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
3. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
4. Use only thinners approved by the paint manufacturer and only within recommended limits.

E. Tinting:

1. Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied.
2. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.03 APPLICATION

A. General:

1. Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth, even surface according to the manufacturer's directions.
5. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
6. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
7. Paint surfaces behind movable equipment the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment with prime coat only.
8. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.

B. Scheduling Painting:

1. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

2. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures:

1. Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.

a. Brushes: Use brushes best suited for the material applied.

b. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

c. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer and as specified, whichever is greater.

E. Electrical items to be painted include, but are not limited to, the following:

1. Exposed conduit and fittings in occupied spaces.

2. Motors provided without factory-applied coatings.

F. Prime Coats:

1. Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime-coated by others.

2. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

G. Pigmented (Opaque) Finishes: Completely cover to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

H. Completed Work:

1. Match approved samples for color, texture, and coverage.

2. Remove, refinish, or repaint work not complying with specified requirements.

3.04 CLEANING

A. Cleanup:

1. At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

2. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Do not scratch or damage adjacent finished surfaces.

3.05 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Protect adjacent walls, floors, and ceilings against splash and overspray. Correct damage by cleaning,

repairing or replacing, and repainting. The Contractor shall be solely responsible for costs to repair damages to Owner's property or private property due to splash and overspray.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates indicated. Unless otherwise specified, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

B. Exterior Ferrous Metal: Provide the following finish systems over exterior ferrous metal that is not immersed. Primer is not required on shop-primed items or previously painted ferrous metals with sound existing coatings.

1. Satin or Semigloss, Polyamide Epoxy with Polyurethane Finish Coat: Two coats over a rust-inhibitive primer to achieve a total dry film thickness of not less than 10 mils:

a. Surface Preparation: SSPC-SP6.

b. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3 mils:

1) Fuller: DP45U902 High Solids Epoxy.

2) PPG: 97-680 Modified Alkyd Primer.

3) Tnemec: Series N69 Hi-Build Epoxoline.

4) Or approved equal.

c. First Coat: Satin or semigloss polyamide epoxy applied at spreading rate recommended by the manufacturer:

1) Fuller: DP45U902 High Solids Epoxy.

2) PPG: 97-53 Aquapon.

3) Tnemec: Series N69 High Build Epoxoline.

4) Or approved equal.

d. Second Coat: Aliphatic polyurethane applied at spreading rate recommended by manufacturer:

1) Fuller: Alithane II DP47U902.

2) PPG: Pitthane Series 95-8400.

3) Tnemec: Endura-Shield Series 73.

4) Or approved equal.

C. Immersed Ferrous Metal, Zinc-Coated Metal, and Ductile Iron Pipe: Provide the following system:

1. Polyamidoamine Epoxy:

a. AWWA D102 Paint System: ICS-1.

b. ANSI/NSF 61 Certified for use inside potable-water storage tanks.

c. Surface Preparation: SSPC-SP 10/NACE 2.

d. Primer: Rust-inhibitive primer applied at spreading rate recommended by the manufacturer to achieve a total dry-film thickness of not less than 4 mils:

1) Tnemec, Series 20 Pota-Pox.

2) SW, Epolon II Multi-Mil Epoxy.

3) Or approved equal.

e. Finish Coat: Applied at spreading rate recommended by the manufacturer to achieve a total dry-film thickness of not less than 11 mils:

1) Tnemec, Series N140 Pota-Pox Plus.

2) SW, Epolon II Multi-Mil Epoxy.

3) Or approved equal.

D. Interior and Exterior Zinc-Coated Metal:

1. Provide the following finish systems over exposed zinc-coated (galvanized) metal surfaces, including existing piping at the aeration basin above the high-water mark, unless otherwise specified:

a. Full-Gloss, Alkyd-Enamel Finish: Two finish coats over a galvanized metal primer.

1) Surface Preparation: For existing surfaces, power tool cleaning per SSPC SP-3. For new galvanized surfaces, solvent cleaning per SSPC SP-1.

2) Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils:

(a) Fuller: 621-05 Blox-Rust Latex Metal Primer.

(b) PPG: 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel.

(c) Or approved equal.

3) First and Second Coats: Full-gloss, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils:

(a) Fuller: 312-XX Compliant Heavy-Duty Enamel.

(b) PPG: 6-282 Speedhide Interior/Exterior Gloss-Oil Enamel.

(c) Or approved equal.

E. Interior Ferrous Metals:

1. Semigloss Enamel Finish: Two coats over primer with a dry film thickness of not less than 2.5 mils per coat:

a. Primer: Synthetic, quick-drying, rust-inhibiting primer.

1) Fuller: 621-04 Blox-Rust Alkyd Metal Primer.

2) PPG: 6-208 Red Inhibitive Metal Primer.

3) Or approved equal.

b. Undercoat: Interior enamel undercoat:

1) Fuller: 220-07 Interior Alkyd Enamel Undercoat.

2) PPG: 6-6 Speedhide Quick-Dry Enamel Undercoater.

3) Or approved equal.

c. Finish Coat: Interior, semigloss, odorless, alkyd enamel:

1) Fuller: 110-XX Fullerglo Alkyd Semigloss Enamel.

2) PPG: 27 Line Wallhide Semigloss Enamel.

3) Or approved equal.

F. Interior and Exterior Ductile and Cast Iron Pipes, Equipment, and Valves: Provide the following finish systems over ductile and cast iron equipment and pipe:

1. Same as for interior and exterior ferrous metal, except as noted below:

a. Surface Preparation: As recommended by equipment manufacturers. Exposed ductile iron pipe to be painted shall be supplied from the manufacturer uncoated.

G. PVC Pipe: Provide the following finish system over exposed PVC pipe:

1. Same as for exposed ferrous metal except as noted below:

a. Surface Preparation: Scarify.

b. Total Dry Film Thickness: 4 mils minimum.

3.07 COLORS

A. Pipe Identification Painting:

1. Color code non-submerged piping except electrical conduit. Paint fittings and valves the same color as pipe.

2. Piping Color Coding: As selected by Owner or Engineer.

3. Pipe Supports: No. 70 light gray as specified in ANSI 359-A-85.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits. Provide as designated herein and as selected by Owner or Engineer.

2. Paint equipment and piping one color as selected.

3. Paint non-submerged portions of equipment the same selected color as the piping it serves, except as itemized below:

a. Dangerous Parts of Equipment and Machinery: OSHA Orange.

b. Fire Protection Equipment and Apparatus: OSHA Red.

c. Radiation Hazards: OSHA Purple.

d. Physical Hazards in Normal Operating Area and Energy Lockout Devices: OSHA Yellow.

e. Safety Equipment, Including, but Not Limited to, Eyewashes and Safety Showers: OSHA Green.

4. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as selected.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the anchorage and bracing for equipment and seismic anchoring and bracing for suspended equipment and equipment over 200 pounds.

1.02 QUALITY ASSURANCE

A. Reference Standards: This section incorporates by reference the latest revisions of the following documents. These documents 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
IBC 2015	International Building Code
ASCE/SEI 7-10	Minimum Design Loads for Buildings and Other Structures

1.03 SUBMITTALS

A. Procedures: See Specification Section 01 33 00.

B. List of freestanding equipment weighing 200 pounds or more.

C. Anchorage details for equipment and freestanding items weighing between 200 and 400 pounds.

D. Sway bracing for elevated or suspended items such as ceiling systems, ducting, conduits, cable trays, and piping.

E. No less than 4 weeks in advance of equipment installation, for items weighing over 400 pounds. Required anchorage and bracing drawings and calculations bearing the stamp of a Professional Engineer; show the criteria used to determine seismic coefficients and forces applied to the equipment, including seismic zone, soil profile type, and importance factors.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. In accordance with IBC, all equipment shall be anchored and braced to resist seismic forces prescribed in the code and ASCE/SEI 7-10, Chapter 13. All equipment includes equipment which is free standing, supported by stand frames, suspended, anchored to walls, and anchored to floors or slabs.

B. Seismic anchorage and bracing for equipment shall be designed by a State of Washington Registered Structural Engineer using the site-specific seismic criteria.

1.05 SITE SEISMIC CRITERIA

A. Short Periods, Sds = 0.865.

B. 1 Second Period, Sd1 = 0.504.

C. Importance Factor, Ip = 1.50.

D. Site Class = D.

E. Occupancy Risk Category: IV.

F. Seismic Design Category: D.

G. Response Modification Coefficient and Amplification Factors: In accordance with ASCE/SEI 7 10 Sections 13.5 or 13.6.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. General: Perform leakage tests on all pipe installed in this project. Furnish all equipment, material, personnel and supplies to perform the tests and make all taps and other necessary temporary connections. The test pressure, allowable leakage and test medium shall be as specified and as described below. Test pressure shall be measured at the highest point on the line, except that pressure at lowest point shall not exceed pipe manufacturer's rated test pressure, unless specifically noted otherwise. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Engineer. All visible leaks shall be repaired, regardless of the test results.

1.02 SUBMITTALS

A. Quality Control Submittals:

1. Testing Plan:

a. Submit prior to testing and include at least the information that follows:

1) Testing dates.

2) Piping systems and section(s) to be tested.

3) Test type, pressure, and duration.

4) Method of isolation.

5) Calculation of maximum allowable leakage for piping section(s) to be tested.

b. Certifications of Calibration: Testing equipment.

2. Certified Test Report(s).

PART 2 - PRODUCT (NOT USED)

PART 3 - EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. In addition to the specific tests detailed herein exfiltration tests in accordance with WSDOT Specification 7-04.3(1)B shall be performed on all piping and results provided for review and record.

C. Accessories: It shall be the responsibility of the Contractor to block off or remove equipment, valves, gauges, etc., which are not designed to withstand the full test pressure.

D. Testing Apparatus: Provide pipe taps, nozzles and connections as necessary in piping to permit testing including valves to isolate the new system, addition of test media, and draining lines and disposal of water, as is necessary. These openings shall be plugged in a manner favorably reviewed by the Engineer after use. Provide all required temporary bulkheads.

E. Correction of Defects: If leakage exceeds the allowable, the installation shall be repaired or replaced and leakage tests shall be repeated as necessary until conformance to the leakage test requirements specified herein have been fulfilled. All visible leaks shall be repaired even if the pipeline passes the allowable leakage test.

F. Test section may be filled with water and allowed to stand under low pressure prior to testing.

G. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Isolate new piping connected to existing piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
3. Test Pressure: As indicated on Pipe Schedule.

H. Gravity Piping:

1. Perform testing after service connections and manholes have been completed between stations to be tested. Testing shall be performed both before and after pipe is buried.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

I. Hydrostatic Testing for Pressure Piping:

1. Fluid: Clean water to prevent corrosion of materials in piping system.
2. Exposed Piping:
   a. Perform testing on installed piping prior to application of insulation.
   b. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
   c. Vent Piping During Filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to pump air pockets.
   d. Maintain hydrostatic test pressure continuously for 30 minutes minimum, and for such additional time as necessary to conduct examinations for leakage.
   e. Examine joints and connections for leakage.
   f. Correct visible leakage and retest. No visible leakage is allowed.
3. Buried Piping:
   a. Test both before and after backfilling has been completed unless otherwise approved by Engineer.
   b. Expel air from piping system during filling.
   c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
   d. Maintain hydrostatic test pressure continuously for 30 minutes minimum, reopening isolation valve only as necessary to restore test pressure.
   e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test. No visible leakage is allowed.
4. Maximum Allowable Leakage:

$$L = \frac{SD(P)1/2}{133,200}$$

Where:

L = Allowable leakage, in gallons per hours.

S = Length of pipe tested, in feet.

D = Nominal diameter of pipe, in inches.

P = Test pressure during leakage test, in pounds per square inch.

5. Correct all visible leaks and any leakage greater than allowable, and retest.

J. Pneumatic Test for Pressure Piping:

1. Do not perform on:
    a. Plastic pipe.
    b. Piping larger than 6 inches.
    c. Buried and other non-exposed piping, unless otherwise indicated.
    d. Specified test pressures above 25 psi.
    e. Where hydrostatic test is possible.
2. Fluid: Oil-free, dry air.
3. Procedure:
    a. 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 connections, examine for leakage.
    b. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
    c. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
    d. Correct visible leakage and retest. No visible leakage is allowed.

K. Hydrostatic Test for Gravity Piping:

1. Testing Equipment Accuracy: Plus or minus 1/2 gallon of water leakage under specified conditions.
2. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
3. Hydrostatic Head:
    a. At least 6 feet above maximum estimated groundwater level in section being tested.
    b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
4. Defective Piping Sections: Replace or test and seal individual joints and retest.

3.02 FIELD QUALITY CONTROL

A. Test Report documentation follows:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.

5. Remarks, including:
    a. Leaks (type, location).
    b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: This section includes requirements applicable to all valves, operators, and accessories. Equipment and appurtenances shall be provided as shown on the Drawings, described in the Specifications, and as required to completely interconnect all equipment with piping for complete and operable systems.

1.02 REFERENCES

A. ASTM International (ASTM).

B. American National Standards Institute (ANSI).

C. American Water Works Association (AWWA).

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS).

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Provide piping and valve layouts detailing quantities, elevations, and dimensions from fixed structures to the valves to be installed. See Section 22 13 16 for additional information.

C. Basis of Design: Where a Basis of Design is specified and the Contractor elects to provide a product other than the Basis of Design, the Contractor is responsible for incorporation of all modifications needed to provide a complete and fully functional system. Additionally, the Contractor is responsible for ensuring that products meet all specified material and workmanship requirements of the specifications even when submitting a named manufacturer or product.

D. Submit data to show that the following items conform to the Specification requirements:

1. Pipe, fittings and accessories shall include:

    a. Manufacturing method and material standards.

    b. Grade of material.

    c. Wall thickness and tolerances.

    d. Pressure rating.

    e. Fitting fabrication details.

2. Submit certified test reports as required herein and by the referenced standard specifications (Product Information).

E. Manuals: Furnish manufacturer’s installation and operation manuals, bulletins, and spare parts lists for each valve.

F. Operator Calculations: Calculations shall be provided for each valve operator to confirm that no more than a 50-pound effort will be needed on the hand wheel, chain wheel, or valve key to open and close the valve through the full range of operational flows and pressures.

G. Affidavits: Furnish affidavits from the valve and accessory manufacturers. Affidavits shall attest that the manufacturer has examined the Contract Drawings and specifications and that the equipment provided will meet the performance criteria and conform to specification requirements.

H. Field test reports as required in Part 3.

1.04 QUALITY ASSURANCE

A. Materials and equipment furnished under this section shall be of manufacturers who have been regularly engaged in the design and manufacture of the materials and equipment for a period of at least 5 years. Demonstrate to the satisfaction of the Engineer that the quality is equal to the materials and equipment made by the manufacturers specifically named herein, if an alternate manufacturer is proposed.

B. Factory Quality Control: The Contractor shall test all products as noted herein and by the reference specifications. All pipe and fittings to be installed under this Contract may be inspected at the plant by the Owner for compliance with these Specifications using an independent testing laboratory selected and paid for by the Owner.

C. Field Quality Control:

1. The Owner will:

a. Inspect field welds and test the welds if it is deemed necessary.

2. The Contractor shall:

a. Perform leakage tests.

b. Be responsible for the costs of additional inspection and retesting by the Owner resulting from noncompliance.

1.05 APPURTENANCES

A. Furnish and install all necessary guides, stem extensions, inserts, anchors and assembly bolts, washers and nuts, hangers, supports, gaskets, couplings and flanges; all other appurtenant items shown on the Drawings, specified or required for the proper installation and operation of the piping; devices included in or on the piping equipment; and piping accessories.

PART 2 - PRODUCTS

2.01 GENERAL

A. Valve, appurtenance, and accessory sizes indicated are nominal inside diameter unless otherwise noted.

2.02 GENERAL MATERIAL REQUIREMENTS

A. Gaskets and Hardware: As specified in Section 22 13 16 - Pipe and Fittings.

2.03 PIPING MATERIALS

A. Piping system type and size shall be as indicated on the Drawings, as specified in Section 22 13 16 - Pipe and Fittings and as detailed within the associated pipe schedule.

2.04 TRANSITION COUPLINGS

A. Provide transition couplings for connections between new and existing gravity piping. The Contractor shall verify the diameter and material of existing pipes prior to procurement of couplings. Couplings shall be rated for a pressure equal to 200 percent of the maximum expected static head.

2.05 VALVES AND ACCESSORIES

A. General Requirements for Valves:

1. All valves of each type shall be the product of one manufacturer.

2. Valve to include operator, actuator, hand wheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation from ground level.
    a. Valves on pipes with center points located higher than 4 feet above grade shall include levers, hand/chain wheels, and chains extending to within 2 feet of grade. All materials shall be provided with a non-galvanized corrosion resistant coating or constructed of stainless steel. Valve position indicator shall be provided and visible while standing at grade.
    b. Buried valves shall be provided with extension stems, stem sleeves, and a 2-inch-square operator with position indicator located within an airport rated valve box sized for a 125,000-pound point load. Valve position shall be indicated via a dial within the valve box.
3. Valve shall be suitable for intended service.
4. Valve shall be full port and shall be of the same nominal size as adjoining pipe.
5. Valve ends shall be provided to suit adjacent piping.
6. Operators shall be sized for the full range of pressures and velocities; supporting operator calculations shall be provided.
7. Valve to open by turning counterclockwise.

B. Gate Valves
1. Valves shall conform to the latest revision of AWWA Standard C515 covering resilient seated gate valves for water supply service. All valves shall be non-rising stem (NRS) type and shall be provided with position indicators.
2. The valves shall have a ductile iron body, bonnet, and O-ring plate. The wedge shall be totally encapsulated with rubber.
3. The sealing rubber shall be permanently bonded to the wedge per ASTM D 429.
4. Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem (in NRS valves).
5. Stems shall have two O-rings located above thrust collar and one O-ring below. Stem O-rings shall be replaceable with valve fully opened and subjected to full pressure. The stems on 4-inch to 20-inch shall also have two low torque thrust bearings located above and below the stem collar to reduce friction during operation.
6. Valves shall be non-directional and full port.
7. The body, bonnet, and O-ring plate shall be fusion bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
8. Manufacturers:
    a. Basis of Design: Kennedy Valve Company, Model KS-RW.
    b. Clow Company.
    c. Or approved equal.

C. Swing Check Valves:

1. Swing check valves located within the valve vault will be provided by the Owner.

D. Ball Valves 3-Inch and Smaller:

1. Ball valves shall be leak tight-closing, shaft mounted type that fully comply with MSS SP-110 and are suitable for stormwater applications.
2. Rating: 1000 psi.
3. Type: Full port, same as line size.
4. Body and Trim: Stainless Steel.
5. Ball: Type 316 stainless steel.
6. Ends: Screw.
7. Stem Seals: PTFE and of a configuration to allow for in-line seal replacement and adjustment.
8. Seats: Replaceable PTFE seats, 15 percent glass filled.
9. Operator: Stainless steel lever with rubber handle coating and indicator stop.
10. Manufacturers:
    a. Apollo.
    b. NIBCO.
    c. Or approve equal.

E. Inline Check Valves:

1. The inline check valve must hold back a minimum 20 feet of pressure and open when experiencing a maximum of 1 inch of head pressure.
2. The pipe internal diameters must be measured and reported to the manufacturer prior to procurement.
3. Valve Material: Buna-N rubber of unibody construction.
4. Band Material: 316 stainless steel.
5. Manufacturers and Products:
    a. Checkmate by Tideflex.
    b. Wastop by Wapro.
    c. Or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Section 22 13 16 - Pipe and Fittings for additional installation requirements. General Handling and Placing:

3.02 INSTALLATION OF COUPLINGS

A. Transition Couplings: Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat. For corrugated metal piping only, Contractor shall use a spray foam product on the exterior of the pipe to fill corrugations.

3.03 INSTALLATION OF VALVES AND ACCESSORIES

A. Use reducing fittings where any change in pipe size occurs between valves or accessories and the attached pipeline. Bushings shall not be used, unless specifically noted on the Drawings. Use eccentric reducing fittings matching inverts wherever necessary to provide free drainage of lines.

B. Install valves and accessories such that all parts are easily accessible for maintenance and operation.

C. Inline rubber check valves shall be installed while being fully within the pipe and shall incorporate a Type 316 stainless steel expandable clamp.

D. Connections between ferrous and non-ferrous piping, valves, accessories or pipe supports shall be made using a dielectric coupling, union, or flange.

E. Install modular mechanical seals or approved equal at all pipe penetrations in concrete structures.

F. Check Valves: Check valves shall be installed in horizontal runs only, unless otherwise shown on the Drawings. Disc, if applicable, shall not open into a bend or another valve.

3.04 PIPE AND VALVE IDENTIFICATION

A. General: Identify all buried and exposed valves with tags as specified below.

B. Valves: Provide each buried valve with a valve tag identifying the pipeline contents, and either its valve number, or the area or item served by the valve for valves without a valve number. The valve tag for inline check valves should be anchored in the adjoining manhole right above the pipe penetration where the valve is housed.

3.05 QUALITY CONTROL

A. Factory Quality Control: The Contractor shall test all products as required herein and by the reference specifications.

B. Leakage Testing: As specified in Section 22 05 40 - Piping Leakage Testing.

C. Contractor shall be responsible for the costs of additional inspection and retesting by the Owner resulting from non-compliance.

3.06 CLEANING

A. As specified in Section 22 13 16 - Pipe and Fittings.

3.07 FIELD TESTING

A. As specified in Section 22 05 40 - Piping Leakage Testing.

END OF SECTION

PART 1 GENERAL

1.01 DEFINITIONS

A. Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.

B. Wetted and Submerged: Submerged, less than 1.5 feet above liquid surface, all supports in the wet well, or in other damp locations.

1.02 SUBMITTALS

A. Shop Drawings:

1. Drawings of piping supports. Identify support, brace, hanger, guide, anchor type material, and finish by catalog number and location.

2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

3. Supporting calculations of piping supports and seismic bracing systems.

1.03 DESIGN REQUIREMENTS

A. General:

1. Seismic Load: Seismic design shall be based on factors given in the Structural General Notes found on the Drawings.

2. Design and provide piping support and seismic bracing systems throughout facility, whether shown or not. Provide seismic bracing to prevent permanent displacement in any direction caused by lateral motion, overturning or uplift.

3. Supports are shown only where specific types and locations are required; additional pipe supports may be required.

4. Meet requirements of MSS SP58, MSS SP69, MSS SP89, and MSS SP127.

5. Contractor may use the latest edition of SMACNA/PPIC, “Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems” in lieu of engineering each application. Contractor shall use Hazard Level “A” as defined in the Guidelines.

B. Pipe Support Systems:

1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.

2. Safety Factor: No less than 5.

3. Maximum Support Spacing and Minimum Rod Size:

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1 inch through 3 inch	8 feet	1/4 inch
4 inch and 6 inch	8 feet	3/8 inch

C. Framing Support System:

1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.

2. Column Members: Size in accordance with manufacturer’s recommended method.

3. Support Loads: Calculate using weight of pipes filled with water.

D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

E. Vertical Sway Bracing: 10-foot-maximum centers or as shown.

PART 2 - PRODUCTS

2.01 GENERAL

A. When items specified or depicted in the Standard Details are not available, fabricate pipe supports of correct material and to the general configuration indicated by catalogs.

B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

C. Materials:

1. Vault, Wet Well, or Wetted and Submerged Conditions: Stainless steel Type 316L.

2. Atmospheric Exposed: Galvanized.

D. All pipe supports shall include braces for seismic loadings.

2.02 ACCESSORIES

A. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP58, Type 40.

2. Manufacturers and Products:

a. Grinnell, Figure 167.

b. B-Line, Figure B3151.

c. Or approved equal.

B. Welding Insulation Saddles:

1. Type MSS SP58, Type 39.

2. Manufacturers and Products:

a. Grinnell, Figure Series 160.

b. B-Line, Figure Series B3160.

c. Or approved equal.

C. Vibration Isolation Pads:

1. Type: Neoprene Waffle.

2. Manufacturers and Products:

a. Mason Industries, Type W.

b. Korfund, Korpad 40.

c. Or approved equal.

2.03 CHANNEL TYPE SUPPORT SYSTEMS

A. Material:

1. Hot-dip galvanized steel.
2. Stainless Steel: Type 316.
3. Nonmetallic: PVC or FRP, both with UV inhibitors and suitable for outdoor use.

B. Channel Size: 12-gauge, 1 5/8-inch-wide series.

C. Members and Connections: Design for all loads with safety factor of 5.

D. Manufacturers and Products:

1. B-Line; Series B22.
2. Unistrut.
3. Or approved equal.

2.04 ANCHORING SYSTEMS

A. Material:

1. Vault, Wet Well, Wetted or Submerged: Stainless steel.
2. Atmospheric Exposed: Galvanized.

B. Size: Sized by the piping support system designer, 1/2 inch-minimum diameter, and as specified in Section 03 15 19 - Anchors, Inserts, and Embedded Products.

2.05 SHOP FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00 - Equipment and Piping Painting.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with the following standards unless shown or specified otherwise:
   a. MSS SP58 - Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application and Installation.
   b. MSS SP69 - Pipe Hangers and Supports Selection and Application (ANSI-approved American National Standard).
   c. MSS SP89 - Pipe Hangers and Supports -Fabrication and Installation Practices.
   d. MSS SP127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
2. Support piping connections to equipment by pipe support and not by the equipment.
3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
4. Support pipe on either side of all equipment, valves, and appurtenances to allow for removal of valves and equipment without impacting the surrounding pipe or overloading adjacent pipe supports.
5. Support no pipe from the pipe above it.

6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
8. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
9. Install lateral supports for seismic loads at all changes in direction and where pipe support does not provide adequate lateral support for tributary seismic loads.
10. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
11. Repair mounting surfaces to original condition after attachments are made.

B. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides (or pipe supports that provide the same function) at all expansion joints and loops.
2. Guide piping on each side of an expansion joint or loop at 4 and 14 pipe-diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying a pipe anchor or alignment guide.

C. Accessories:

1. Insulation Shield: Install on insulated non-steel piping. Oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.
3. Vibration Isolation Pad: Install under base flange or pedestal-type pipe supports adjacent to equipment, and where required to isolate vibration.
4. Dielectric Barrier:
    a. Install between carbon steel supports and copper or stainless steel pipe.
    b. Install between stainless steel supports and dissimilar metal piping.
5. Electrical Isolation: Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces of black and galvanized steel components as specified in Section 09 90 00 - Equipment and Piping Painting. All exposed galvanized surfaces shall be provided with a corrosion resistance non-galvanized paint or coating.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide electrical materials and labor to satisfactorily complete electrical work shown on the Drawings, specified, or neither shown nor specified but necessary for a complete and fully operating facility.

B. Mounting details of equipment, devices, light fixtures, raceways, junction boxes, etc., are not usually shown or specified, provide per industry standard practice and code requirements as necessary for proper installation and operation. This work shall be included in the Contractor's estimate, the same as if specified or shown.

1.02 RELATED SECTIONS

A. The work of all sections within Division 26 - Electrical and Division 40 - Process Interconnections, is related to the work of this section. Other sections may also be related to the proper performance of this work. It is the Contractor's responsibility to perform all the work required by the Contract Documents.

1.03 SUBMITTALS

A. Procedures: See Division 01 - General Requirements.

B. Submittal package shall be organized by equipment type:

1. Include separators and tabs or other means of identifying each item.

C. Shop Drawings: Show dimensions, physical configurations, methods of connecting equipment, mounting details, wiring schematics, etc.:

1. Drawings shall be complete with device numbers, wire numbers, and terminal board numbers.

D. Submit fabrication details and nameplate legends:

1. Include material lists and/or bills of material.

E. Catalog Cut Sheets: Show model numbers, product technical specifications, ratings, range, weight, accuracy, diagrams, application information, etc.:

1. Manufacturers' catalog cuts, specifications, or data sheets shall be clearly marked to delineate the options or styles to be furnished.

F. Bill of Material (BOM): BOM shall include equipment item number, quantity, manufacturer, part number, model number, and descriptions.

G. Nameplate schedule.

H. Qualifications of testing organization and personnel meeting requirements of ATS-2017, Section 3.

I. Inspection and acceptance testing reports per ATS-2017, Paragraph 5.4, or MTS-2015, Paragraph 5.4 for equipment for which tests are required in this and other Division 26 sections.

J. Field test results specified in Part 3 of this section.

K. Operation and Maintenance manuals in compliance with Division 01 - General Requirements.

L. Spare Parts: For each piece of equipment, submit a list of recommended spare parts. Include part numbers and the name, address, and telephone number of the supplier.

M. Record Drawings:

1. Contract Drawings: Upon completion of the work, transfer the Contractor maintained As-Built Drawings to a clean set of full-size Drawings with red ink to indicate additions and green ink to indicate deletions:

a. Submit these full-size Drawing markups to the Engineer and copy to the Owner.

2. Equipment Manufacturer Shop Drawings: Upon completion of the work, submit the As-Built Drawings from the equipment manufacturer with any modifications performed in the field:

a. Submit these Drawings in both an Adobe Acrobat [*.PDF] format and an Autodesk AutoCAD [*.DWG] format.

1.04 QUALITY ASSURANCE

A. Variances: In instances where two or more codes are at variance, the most restrictive requirements shall apply.

B. Standards: Equipment shall conform to applicable standards of American National Standards Institute (ANSI), Electronics Industries Association (EIA), Institute of Electrical and Electronics Engineers (IEEE), and National Electrical Manufacturers Association (NEMA):

1. The revisions of these standards in effect on the date of issuance of the Contract Documents shall apply.

C. Electrical equipment, materials, and installation methods shall conform to applicable local and state codes as well as the editions of the following in effect on the date of issuance of the Contract Documents:

1. National Electrical Code (NEC).

2. National Electrical Safety Code (NESC).

3. National Electrical Contractors Association (NECA).

D. Electrical equipment must be listed or labeled by a Nationally Recognized Testing Laboratory (NRTL) for which an NRTL acceptance listing or labeling exists. An NRTL is recognized by Occupational Safety and Health Administration (OSHA) as being capable of independently assessing equipment for compliance to safety requirements and applicable standards. UL is an example of an NRTL.

E. Provide equipment with service entrance labels in those cases where the NEC requires such labels.

F. Series short circuit ratings for protective devices are not allowed.

G. Acceptance testing, studies, and reports per ATS-2017 or MTS-2015 for equipment for which tests are required in this and other Division 26 sections:

1. Testing organization and personnel performing tests shall meet the qualifications of ATS-2017, Section 3; MTS-2015, Section 3; and be certified per ANSI/NETA ETT 2015, Standard for Certification of Electrical Testing Technicians.

1.05 DRAWINGS

A. The Electrical Drawings are diagrammatic; exact locations of products shall be verified with the Engineer prior to installation. Except where special details are used to illustrate the method of installation of a particular piece or type of equipment or material, the requirements or descriptions in this and other Division 26 sections shall take precedence in the event of conflict.

B. Field-verify scaled dimensions on Drawings.

C. Review the Drawings and specification divisions of other trades and perform the electrical work that will be required for the installations.

D. Submit in writing to the Engineer details of any proposed changes in or departures from these Contract Documents along with the explanations for the changes:

1. Make no changes or departures without the prior written favorable review of the Engineer.

E. Maintain a set of As-Built Drawings on-site that document/redline changes made to both the Contract Drawings and approved equipment manufacturer Shop Drawings.

1.06 JOB CONDITIONS

A. Operations:

1. Keep power shutdown periods to a minimum.

2. Carry out shutdowns only after the schedule has been favorably reviewed by the Owner and coordinated with the operations personnel.

B. Construction Power:

1. Contractor shall make arrangements for the required construction power.

2. When required, provide equipment, materials, and wiring in accordance with the applicable codes and regulations.

3. Upon completion of the project, remove temporary construction power equipment, material, and wiring from the site as the property of the Contractor.

C. Storage: Provide conditioned storage for equipment and materials per manufacturer's requirements that will become part of the completed facility so that it is protected from weather, dust, water, or construction operations.

1.07 DAMAGED PRODUCTS

A. Notify the Engineer in writing in the event that any equipment or material is damaged.

B. Obtain approval by the Owner and prior favorable review by the Engineer before making repairs to damaged products.

1.08 MATERIALS

A. Provide first quality, new materials, free from defects, and suitable for the intended use and space.

B. Where two or more units of the same class of material are required, provide products of a single manufacturer.

C. Unless otherwise indicated, provide materials and equipment that are the standard products of manufacturers regularly engaged in the production of such materials and equipment.

1. Provide the manufacturer's latest standard design that conforms to these Specifications.

1.09 LOCATIONS

A. General: Use equipment, materials, and wiring methods suitable for the types of locations in which they are located, as defined in Paragraph B herein.

B. Definitions of Types of Locations:

1. Dry Locations: Indoor areas which do not fall within the definitions below for Wet, Damp, Hazardous, or Corrosive Locations and that are not otherwise designated on the Drawings.
2. Wet Locations: Locations exposed to the weather, whether under a roof or not, or designated as Wet Locations by applicable codes and regulations, unless otherwise designated on the Drawings.
3. Damp Locations: Location wholly or partially underground, or having a wall or ceiling forming part of a channel or tank, or designated as Damp Locations by applicable codes and regulations, unless otherwise designated on the Drawings.
4. Corrosive Locations: Wet Well and areas where corrosive materials, including chlorine or sulfur dioxide gas, sodium hypochlorite solutions, sulfuric acid, or liquid polymer are stored or processed. These areas are shown on the Drawings. Specific locations which are defined as Corrosive Locations include:
    a. Hazardous (Classified) Locations: Hazardous (Classified) Locations per the NEC.

PART 2 - PRODUCTS

2.01 STANDARD OF QUALITY

A. It is the intent of these Specifications and Drawings to secure high quality in materials, workmanship, and equipment in order to facilitate operation and maintenance of the facility.
    1. Ancillary equipment and materials not identified in these specifications or on the Drawings shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items.
    2. For uniformity, only one manufacturer will be accepted for each type of product. Equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for stresses that may occur during fabrication, transportation, erection, and continuous or intermittent operation.
    3. Equipment shall be adequately stayed, braced, and anchored and shall be installed in a neat and workmanlike manner.
    4. Appearance, as well as utility, shall be given consideration in the design of details.

2.02 GENERAL FASTENERS

A. Fasteners for securing equipment to walls, floors and the like shall be 316 stainless steel.

B. When fastening to existing walls, floors, and the like, provide capsule or wedge anchors, not expansion shields:
    1. Size anchors to meet load requirements.

2.03 PAINTING AND COATING

A. Equipment: Refer to each electrical equipment section of these Specifications for painting and coating requirements of equipment and enclosures.

B. Repair any final finish that has been damaged or is otherwise unsatisfactory using touchup materials approved by the manufacturers, to the satisfaction of the Owner.

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall be performed by craftsmen skilled in their trade.

B. Work shall present a neat and finished appearance.

C. Equipment and material shall be new and free from defects. All material and equipment of the same or similar type shall be of the same manufacturer.

D. Install equipment in strict accordance with the manufacturer's instructions unless directed otherwise:

1. Wherever a conflict occurs between manufacturer's instructions, codes and regulations, or these Contract Documents, follow Engineer's direction.

2. Keep a copy of submitted manufacturer's installation instructions on the job site available for review.

E. Provide protection for materials and equipment against loss or damage:

1. Protect all equipment provided in the Contract and any existing equipment affected by this Contract from the effects of weather (e.g.: new holes in existing equipment for installation of new equipment, etc.).

2. Prior to installation, store items in indoor locations. In addition, items subject to corrosion under damp conditions, and items containing insulation, such as transformers, motors, and control, shall be stored in indoor, heated, dry locations.

F. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation:

1. Cap conduit runs during construction with manufactured seals.

2. Keep openings in boxes or equipment closed during construction.

G. Do not cut or notch any structural member or building surface without specific approval of Engineer:

1. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition using skilled craftsmen of the trades involved at no additional cost to the Owner.

H. Keep the premises free from accumulation of waste material or rubbish:

1. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of devices and equipment.

2. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

I. Label electrical and control equipment, including electrical switchgear, VFD panels, motor starter panels, generator sets, automatic transfer switches, control panels, equipment within electrical and control panels, disconnect switches, motors, pumps, local control stations, instrument transmitters, and analytical controllers.

3.02 FIELD TESTS

A. General:

1. Contractor shall use NETA Acceptance Testing Specifications (ATS) for all new equipment installed under this Contract and NETA Maintenance Testing Specifications (MTS) for all

existing equipment reused under this Contract unless otherwise directed by the Project Representative.

2. Give a minimum of 5 working days of notice to the Engineer prior to any test to permit witnessing the test.

3. Testing Contractor shall be NETA certified and shall submit copy of certification for favorable review prior to testing.

4. Record test measurements on applicable NETA test report forms.

5. Prepare and submit a Test Report per NETA standards summarizing the final test procedures and test results.

B. The Contractor shall provide all materials, equipment, labor, and technical supervision to perform such tests and inspections. It is the intent of these tests to ensure that all electrical equipment is operational within industry and manufacturer tolerances and is installed in accordance with the Contract Documents and manufacturer's instructions. The tests and inspections shall determine the suitability for energization.

C. Retesting will be required for all unsatisfactory tests after the equipment or system has been repaired. Retest all related equipment and systems if required by the Engineer.

D. Tests:

1. Testing shall include the tests specified in Division 26 equipment specifications.

2. Insulation Resistance, Continuity, and Rotation:

a. Perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment including all motors, 1/2 horsepower and larger, prior and in addition to tests specified herein.

b. Any system material or workmanship that is found defective on the basis of acceptance tests shall be reported directly to the Engineer.

c. The Contractor shall maintain a written record of all tests and upon completion of project, assemble and certify a final test report.

3. Motor Current: Measure and record current in each phase for each new motor over 5 hp. Include measurement of the motor terminal voltages and motor currents when the motor is being operated at normal operating loads. For motors that are fed by variable frequency drives, use true-rms-reading instruments in making test measurements.

4. Operational Tests: Operationally test all circuits to demonstrate that the circuits and equipment have been properly installed, adjusted, and are ready for full-time service. Demonstrate the proper functioning of circuits in all modes of operation including alarm conditions, and demonstrate satisfactory interfacing with the data acquisition and alarm systems.

3.03 RECORD DRAWINGS

A. Maintain a set of As-Built Drawings on site that documents changes made to both the Contract Drawings and approved equipment manufacturer Shop Drawings. Provide a copy of these As-Built Drawings to the Owner/Engineer for approval prior to and as a part of the substantial completion process. Substantial completion will not be awarded if the Drawings are not in an acceptable readable form and approved by the Owner/Engineer.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of conductors and cables rated 600 V used for power, lighting, and receptacle circuits.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Submit catalog cut sheets.

C. Submit insulation test results.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. General: All conductors shall be copper. Wire or cable not specifically shown on the Drawings or specified, but required, shall be of the type and size required for the application and in conformance with the applicable code and/or manufacturer's requirements. All insulated conductors shall be identified with printing colored to contrast with the insulation color.

B. Power and Control Conductors, 600 V and Below:

1. No. 14 AWG and larger shall be 600 V, copper, stranded, Type XHHW-2, 90 degrees C wet/dry cross-linked polyethylene in accordance with NEMA WC57/ICEA S-73-532 (control cable), NEMA WC70/ICEA S-95-658 (power cable).

2. Fixture wire shall be 600 V, silicone rubber insulated, 200 degrees C, UL Type SF-2, with stranded copper conductors.

3. Flexible cords and cable shall be 600 V, Type SOOW with ethylene-propylene-rubber insulation, in accordance with UL 62. Rated for Extra Hard-Usage. Shall conform to physical and minimum thickness requirements of NEMA WC 8.

4. Cords shall be 600 V, 2-conductor plus ground, Type SO, hard service, of adequate length and with grounding type plug attached, rated in amperes as shown on the Drawings.

5. Manufacturers: Houston Wire and Cable, Southwire, Okonite, or approved equal.

2.02 SPLICES AND TERMINATIONS OF CONDUCTORS

A. Splices:

1. Wire and Cable Splicing Materials and Applications:

a. For Lighting Systems and Power Outlets: Wire nuts shall be twist-on type insulated connectors utilizing an outer insulating cover and a means for connecting and holding the conductors firmly. Wire nuts shall be suitable for connecting two to four copper conductors of No. 14 or No. 12 AWG size or two or three No. 10 AWG copper conductors.

b. All Equipment: Crimp-type connectors shall be insulated type, suitable for the size and material of the wires and the number of wires to be spliced and for use with stranded conductors.

c. Equipment and Power Conductors: Bolted pressure connectors shall be suitable for the size and material of the conductors to be spliced. Connectors shall be of the split bolt or bolted split sleeve type in which the bolt or setscrew does not bear directly on the conductor.

d. All Equipment: Epoxy splice kits shall include epoxy resin, hardener, and mold, and shall be suitable for use in wet locations and hazardous locations.

e. All wire and cable splicing materials shall be UL Listed.

2. Terminal Cabinets (Not Marshaling Cabinets): Termination system shall include insulated, crimp-type connectors. Coordinate the lug and boards for correct fit. All terminations shall include marker sleeves.

B. Terminations:

1. Low-Voltage Terminations:

a. Crimp-type terminals shall be UL Listed, self-insulating sleeve type, with ring or rectangular type tongue, suitable for the size and material of the wire to be terminated and for use with either stranded conductors.

b. Terminal lugs shall be Listed and of the split bolt or bolted split sleeve type in which the bolt or setscrew does not bear directly on the conductor. Tongues shall have NEMA standard drilling.

c. Crimp with manufacturer-recommended ratchet type tool with calibrated dyes. Hand crimping tools are not acceptable.

d. Provide VFD cable terminations per cable manufacturer’s requirements and recommendations.

C. Tape used for splices and terminations shall be compatible with the insulation and jacket of the cable and shall be of plastic material. Tape shall conform to UL 510.

D. Wire markers shall be heat shrink type (Raychem; T&B; or approved equal). Wire numbers shall be permanently imprinted on the markers.

PART 3 - EXECUTION

3.01 CONDUCTOR INSTALLATION

A. Provide the following types and sizes of conductors for the uses indicated for 600 V or less:

1. Stranded Copper, Sizes No. 12 and No. 10 AWG: As shown on the Drawings for circuits for receptacles, switches, and light fixtures with screw type terminals.

2. Stranded Copper, Size No. 14 AWG and Larger: As shown on the Drawings for the control of motors or other equipment. Size No. 14 shall not be used for power supplies to any equipment.

3. Stranded Copper, Sizes No. 12 AWG and Larger: As shown on the Drawings for motors and other power circuits.

4. Fixture Wire: For connections to all fixtures in which the temperature may exceed the rating of branch circuit conductors.

B. Color Coding: Provide color coding for all circuit conductors. Insulation color shall be white for neutrals and green for grounding conductors. An isolated ground conductor shall be identified with an orange tracer in the green body. Ungrounded conductor colors shall be as follows:

1. 208Y/120 V, Three-Phase, Power: (A) Black, (B) Red, and (C) Blue.
2. 480Y/277 V, Three-Phase, Power: (A) Brown, (B) Orange, and (C) Yellow.
3. 240/120 V, Three-Phase, Power: (A) Black, (B) Orange, and (C) Blue.
    a. Mark high leg of 4-wire grounded delta system per Article 110.15 of the NEC.
4. 120/240 V, Single-Phase, Power: (A) Black and (B) Red.
5. 120 Vac, Control: Red.
6. 24 Vdc Control.
    a. DC Common: White with blue strip.
    b. DC Control (+): Blue.
    c. DC Signal (Discrete): Purple.
7. Analog:
    a. Analog signal (+): White or Red.
    b. Analog signal (-): Black.

C. Color-coding shall be in the conductor insulation for all conductors No. 10 AWG and smaller. For larger conductors, color shall be either in the insulation or in colored plastic tape applied at every location where the conductor is readily accessible (e.g., enclosures, pull boxes, and junction boxes).

D. Exercise care in pulling wires and cables into conduit or wire-ways so as to avoid kinking, putting undue stress on the cables, or otherwise abrading the cables. No grease will be permitted in pulling cables. Only soapstone, talc, or Listed pulling compound will be permitted. The raceway construction shall be complete and protected from the weather before cable is pulled into it. Swab conduits before installing cables and exercise care in pulling to avoid damage to conductors.

E. Manufacturer’s cable-pulling tension shall not be exceeded.

F. Wrap all cables in manholes with fireproofing tape. Extend tape 1 inch into ducts.

G. Cable bending radius shall be per applicable code and manufacturers requirements. Install feeder cables in one continuous length unless splices are favorably reviewed.

H. Provide an equipment-grounding conductor, whether or not it is shown on the Drawings, in all flexible conduit and all raceways.

I. In panels, bundle incoming wire and cables, No. 6 AWG and smaller; lace at intervals not greater than 6 inches; neatly spread into trees; and connect to respective terminals. Allow sufficient slack in cables for alterations in terminal connections. Perform lacing with plastic cable ties or linen lacing twine. Where plastic panel wiring duct is provided for cable runs, lacing is not necessary when the cable is properly installed in the duct.

J. In wire-ways, ty-wrap/secure wire and cables at a minimum of every 4 feet.

K. For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not exceeding 12, and arrange to provide protection from chafing and excess flexing when the hinged member is moved.

L. Install and terminate VFD cable per cable manufacturer’s requirements and recommendations.

3.02 CONDUCTOR SPLICES AND TERMINATIONS

A. Splices: Install all conductors without splices unless necessary for installation, as determined by the Engineer. Splices, when permitted, and terminations shall be in accordance with the splice or termination kit manufacturer's instructions. Splice or terminate wire and cable as follows:

1. Watertight Splices: Splices in concrete pull boxes, for any type of cable or wire, shall be watertight. Make splices in low-voltage cables using epoxy resin splicing kits rated for application up to 600 V.

B. Terminations: Terminate stranded No. 14 wire using crimp-type terminals where not terminated in a box lug-type terminal. Terminals must be coordinated with type of terminal board where provided.

3.03 FIELD TESTS

A. Insulation Resistance Tests:

1. Perform an insulation resistance test for all circuits 150 V to ground or more and for all motor circuits over 1/2 horsepower.

2. Test cables per NETA ATS-2017, Section 7.3.2. Submit results for review.

B. Phase Rotation: The phase rotation of all circuits shall be clockwise in sequence as determined with a phase rotation meter and shall produce the standard direction of rotation specified for poly-phase induction motors in NEMA MG1. The Contractor shall verify that each three-phase service, feeder, and branch circuits meet this requirement. A record shall be kept at each circuit tested and, on completion, submitted to the Engineer for review.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of electrical grounding equipment.

B. This section specifies the system for grounding electrical equipment, exposed non-energized metal surfaces of equipment, and metal structures.

C. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Submit catalog cut sheets.

C. Shop Drawings.

D. Test data.

PART 2 - PRODUCTS

2.01 GENERAL

A. The grounding systems shall consist of the ground rods, grounding conductors, ground bus, ground fittings and clamps, and bonding conductors to water piping and structural steel as shown on the Drawings or as required to meet the requirements of the NEC. One system shown provides service and separately derived system grounds. A second system is an electronic ground system to provide for the discharge of static electricity.

2.02 SYSTEM COMPONENTS

A. Ground Rods:

1. Ground rods shall be cone-pointed, copper-clad Grade 40 HS steel rods conforming to ASTM B 228.

2. The welded copper encased steel rod shall have a conductivity of not less than 27 percent of pure copper.

3. Rods shall be not less than 3/4 inch in diameter and 10 feet long, unless otherwise indicated.

4. Rods longer than 10 feet shall be made up of 10-foot units joined together with threaded couplings. Increase rod diameter sufficiently to prevent the rod from bending or being damaged.

5. The manufacturer’s trademark shall be stamped near the top.

B. Ground Conductors:

1. Buried conductors shall be medium-hard drawn bare copper; other conductors shall be soft drawn copper.

2. Sizes over No. 6 AWG shall be stranded.

3. Coat all ground connections, except the exothermic welds, with electrical joint compound, nonpetroleum type, listed for copper and aluminum applications.

4. If cable sizes are not specified, the minimum sizes shall be as follows:

a. 15 kV - 480 V Transformer: 250 MCM
b. 15 kV Load Interrupter: 4/0 AWG
c. 480 V Switchgear: 4/0 AWG
d. 480 V MCC and Switchboards: 2/0 AWG
e. Lighting Panels: 1/0 AWG
f. Exposed Metal: 2 AWG
g. Control Panels: 12 AWG

C. Ground Connections:
1. Exothermic Connectors:
a. Connection to ground rods and buried connections shall be by exothermic weld.
b. Manufacturers: Thermoweld, Cadweld, or approved equal.
2. Binding Post Connectors:
a. Lugs for attachment of cables to steel enclosures shall be of the binding post type with a 1/2 13 NC stud.
b. Each post shall accommodate cables from No. 4 AWG to No. 4/0 AWG.
3. Irreversible Compression Connectors:
a. Cast copper.
b. Manufacturers: Thomas and Betts, Burndy, or approved equal.
4. Bolted Connectors:
a. Manufacturers: Burndy, O. Z. Gedney, or approved equal.

D. Ground Rod Boxes:
1. Boxes shall be 9-inch-diameter precast concrete units with hot-dip galvanized traffic covers.
2. Units shall be 12 inches deep.
3. Covers shall be embossed with the wording “Ground Rod”.

E. Ground Bus:
1. Ground bus shall be a high-conductivity copper-alloy strap measuring 3/16 inch by 1 1/4 inch and of lengths as shown on the Drawings.
2. Bus shall be predrilled and tapped to accept 8/32 brass machine screws on 12-inch centers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ground all equipment for which a ground connection is required per NEC whether or not the ground connection is specifically shown on the Drawings.

B. Provide a ground rod box for each ground rod so as to permit ready access for the connection and/or removal of any pressure connectors to facilitate testing.

C. Bond metallic water piping at its entrance into each building. Ground separately derived electrical system neutrals to the metallic water piping in addition to the system driven ground per NEC requirements.

D. Make embedded or buried ground connections, taps, and splices with irreversible compression connectors or exothermic welds. Coat ground connections.

E. Effectively bond structural steel for buildings to the grounding system using exothermic welds.

F. Prior to making ground connections or bonds, clean metal surface at the point of connection.

G. Install rubber mats in front of low-voltage switchboards and switchgear, medium-voltage switchgear, and motor control centers.

3.02 RACEWAY GROUND

A. Metallic Conduits:

1. Assembled to provide a continuous ground path and bonded using insulated grounding bushings.

2. Bond using insulated grounding bushings.

B. Non-Metallic Conduits: Insulated ground conductor sized in compliance with the NEC.

C. Grounding Bushings: Connected to the grounding system using conductors sized in compliance with NFPA 70.

D. Provide a ground wire in every conduit carrying a circuit of over 50 V to ground.

3.03 EQUIPMENT AND ENCLOSURE GROUND

A. Connect electrical and distribution equipment to the grounding system. Cables sized as specified.

B. Connect non-electrical equipment with metallic enclosures to the grounding system.

C. Securely bond transformer yard fences and gates as specified.

3.04 TESTING

A. Conduct ground-resistance tests using a ground megohmmeter with a scale reading of 25 ohms maximum.

B. Test methods shall conform to NETA Standard ATS using the three-electrode method. Conduct tests only after a period of not less than 48 hours of dry weather.

C. Maximum resistance shall be 5 ohms. If 5 ohms cannot be achieved, add additional ground rods and ground grid conductors until the maximum resistance is achieved. If soil conditions provide that this value is impossible to achieve, add ground rods and conductors to achieve the lowest resistance realistic and submit to the Engineer for favorable approval. If Engineer does not approve the value and configuration, follow Engineer’s direction for further reduction of ground resistance.

D. Furnish to the Engineer a test report with recorded data of each ground rod location.

E. Furnish a separate report on the rubber mats. Make measurements in conformance with manufacturer’s instructions.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for hangers and supports for electrical systems.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Submit catalog cut sheets.

C. Submit sealed structural Drawings when raceway and cable tray support systems require design by a registered Engineer.

1.03 SYSTEM DESCRIPTION

A. Raceway and cable tray supporting systems, structures, and elements shall be designed to meet seismic and other building structural requirements and to support the static and dynamic load of the wiring and raceways that they will carry.

PART 2 - PRODUCTS

2.01 RACEWAY SUPPORTS

A. Conduit Supports:

1. Provide hot-dip galvanized framing channel with end caps to support groups of conduit. All associated hardware shall be hot-dip galvanized.

2. Individual conduit supports shall be one-hole hot-dip galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required.

3. Conduit supports for PVC-coated rigid steel and PVC conduit systems shall be one hole PVC-coated rigid steel or clamps conduit wall hangers.

4. In corrosive areas (e.g., inside and on top of Headworks Building), all conduit support hardware (e.g., channels, strut, threaded rods, nuts, anchors, and clamps) for single and multiple conduits shall be 316 stainless steel unless specified on Drawings.

2.02 GENERAL FASTENING AND SUPPORT HARDWARE

A. Unless otherwise specified, all fasteners, anchors, clamps, supports, strut, plates, posts, and brackets shall be 316 stainless steel. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is 3/8 inch.

PART 3 - EXECUTION

3.01 GENERAL

A. Treat exposed mail threads, cut surfaces, and damaged ends with corrosion-resistant coatings, such as “Devcon Z” prepared by Subox Coatings, “Galvanox Type I” prepared by Pedley-Knowles, or approved equal. Application shall follow manufacturer’s recommendation.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of electrical conduits, wireways, pull boxes, and fittings. Raceways shall be provided for all wiring unless shown or specified otherwise.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Submit catalog cut sheets.

PART 2 - PRODUCTS

2.01 RACEWAY

A. Requirements for raceway types are listed in the RACESPECs sheets at the end of this section.

2.02 BOXES AND FITTINGS

A. Junction Boxes, Pull Boxes and Wiring Gutters:

1. Indoor:

a. Type FD cast ferrous for all device boxes and for junction boxes less than 6-inches square. NEMA 12 welded steel 6-inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight.

b. Conduit Bodies: Ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.

2. Outdoor:

a. Type FD cast ferrous for all devices and for junction boxes less than 6-inches square. NEMA 4X stainless steel for 6-inches square and larger.

3. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors or removable covers.

4. Boxes and enclosures in indoor corrosive areas shall be NEMA 4X stainless steel or nonmetallic.

5. Boxes in classified areas shall be NEMA Class 7 galvanized cast ferrous.

6. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code.

7. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle.

8. Covers larger than 3 by 4 feet shall be split.

B. Conduit Seals:

1. Conduit seals shall be explosion-proof with a minimum 40 percent wire fill capacity of the EYSX type. Where shown on Drawings, use retrofit conduit sealing fittings of the EYSR type.

2. Install conduit seals for use in classified areas as shown on Drawings or where any conduit leaves the classified space.
3. Use PVC-coated fittings with urethane interior coating for PVC-coated GRS; use copper free cast aluminum for rigid aluminum.
4. The sealing compound shall be as prescribed by the manufacturer of the sealing conduit body.
5. Use the sealant, such as Chico, in areas that are defined as hazardous and meet the NEC requirements for Article 500.

2.03 UNDERGROUND MARKING TAPE

A. Six-inch-wide, detectable, metallic-lined tape with red polyethylene film on top and clear polyethylene film on the bottom.

B. Tape legend shall be clearly printed with black over red tape and shall read “CAUTION ELECTRIC LINE BURIED BELOW”.

C. Use for early warning protection of underground raceways.

D. Manufacturers: Brady “Identoline”, Services and Materials “Buried Underground Tape”, Somerset (Thomas & Betts) “Protect-A-Line”, or approved equal.

2.04 FIRESTOPS

A. Apply in accordance with manufacturer’s recommendations.

B. Manufacturers: Flamemastic 77, Vimasco No. 1-A, or approved equal.

C. Products which are affected by water are not acceptable.

PART 3 - EXECUTION

3.01 GENERAL

A. Specific raceway types and applications are indicated on the Drawings and/or in the raceway schedule. When not indicated on the Drawings and/or in the raceway schedule Table A specifies the type of raceway required for each location and application by RACESPEC sheet. Use fittings, hubs, and boxes as specified by the raceway type in RACESPEC. Unless otherwise indicated, in Table A, unscheduled conduit shall be galvanized, rigid steel, RACESPEC type GRS.

TABLE A

Location	Application/Condition	RACESPEC
Indoor noncorrosive	Exposed	GRS
Indoor corrosive	Exposed; includes Wet Well location	PRS
Outdoor	Exposed	PRS
Concealed	Embedded in concrete structure or beneath slab on-grade	PVC40
Underground	Instrumentation, communications and data signals encased in concrete, duct bank	GRS
Underground	Instrumentation, communications and data signals directly buried	PRS
Underground	Power and control directly buried	PVC40
Underground	Power and control encased in concrete, duct bank	PVC40
Nonhazardous	Final connection to equipment and light fixtures	LFS
Underground	Telephone service direct buried	PVC80
Architecturally finished areas	Final connection to light fixtures	FLEX
Transition	Above-grade to/from below-grade	PRS

3.02 CONDUIT

A. General:

1. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

2. Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

3. Provide conduit and raceway systems that are electrically continuous per electrical code requirements or provide additional ground conductors as required by the electrical code.

B. Indoor and Outdoor Conduit Systems:

1. Unless otherwise indicated, in general, conduit inside structures shall be exposed.

2. Unless otherwise indicated, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.

3. Install conduit to conform to the requirements of the RACESPEC sheets and the following:

a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.

b. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.

c. Exposed conduit shall be run on supports spaced not more than 10 feet apart.

d. Where three or more conduits are located in parallel run, space them out from the wall using framing channel.

e. Where conduits are suspended from the ceiling, support systems shall comply with the requirements of Section 26 05 29 - Hangers and Supports for Electrical Systems.

f. Secure conduit rack supports to concrete walls and ceilings by means of cast in place anchors or framing channel concrete inserts.

g. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.

h. Install conduits between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, place conduits under the reinforcement.

i. Route conduit clear of structural openings and indicate future openings.

j. Flash and seal watertight those conduits which pass through roofs or metal walls.

k. Neatly group conduit into any openings cut into concrete and masonry structures, and grout using non-shrink type grout.

l. During construction, cap conduits to prevent entrance of dirt, trash, and water.

m. Terminate exposed conduit stubs for future use with galvanized pipe caps.

n. Determine concealed conduit stub-up locations from the manufacturer's Shop Drawings.

o. Terminate concealed conduit for future use in equipment or by galvanized couplings plugged flush with structural surfaces.

p. Where the Drawings indicate future duplication of equipment wired hereunder, provide concealed portions of conduits for future equipment.

q. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.

r. Terminate all conduits that enter enclosures by fittings that ensure that the NEMA rating of the enclosure is not affected or changed.

s. Transitions from concealed or underground or embedded locations to exposed or above-grade locations shall be made using PVC-coated rigid steel conduit for a distance of at least 12 inches on either side of transition. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry, or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.

t. Conduit across structural joints where structural movement is allowed shall have an OZ Gedney "Type DX", Crouse-Hinds "Type XD", or approved equal, bonded, weathertight expansion and deflection fitting of that conduit size.

u. Treat cut surfaces or damaged ends with corrosion-resistant coatings, such as "Devcon Z" prepared by Subox Coatings, "Galvanox Type I" prepared by Pedley Knowles, or approved equal. Application shall follow manufacturer's recommendation.

v. At all boxes and equipment, provide insulated-type metallic grounding bushings for metallic conduits. Bond together all conduits to provide continuity of the equipment grounding system. Size bonding conductor per NEC.

w. Clean, cap/plug, and provide all spare raceways with a nylon pull rope.

C. Underground Conduit Systems:

1. All excavation, backfilling, and concrete work shall conform to respective sections of these Specifications. Underground conduit shall conform to the following requirements:
    a. Exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.
    b. Unless otherwise indicated, underground conduits and conduit banks shall have 2 feet minimum earth cover.
    c. Using a special rubber gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements, seal watertight those conduits not encased in concrete and passing through walls that have one side in contact with earth.
    d. Immediately upon completion of pouring concrete, thoroughly swab conduits on the inside. After the concrete has set, and before backfilling, pull a mandrel, having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, through each conduit. If the mandrel showed signs of protrusions on the inside of the conduit, repair or replace the conduit.
    e. Clean, cap/plug, and provide all spare raceways with a nylon pull rope.
2. Provide detectable underground marking tape placed 6 to 12 inches below finished grade and directly above the conduit.
3. Transition from Underground to Above Grade: Provide PRS conduit sweep and PRS conduit riser to a distance of at least 12 inches above grade.
4. Underground sweeps shall be PRS unless otherwise noted on the Drawings.
5. Unless otherwise indicated, use 6-inch coarse sand backfill on all sides of underground conduit.

D. Existing Conduit Systems:
1. Where existing conduit raceways are utilized:
    a. Blow out the conduit using compressed air to remove foreign material and water. Pull wire brush through conduit and blow out the conduit a second time using compressed air.
    b. Pull a test mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, through each spare conduit. If the mandrel showed signs of protrusions on the inside of the conduit, repair or replace the conduit. Notify the Engineer if the existing conduit cannot be utilized.
    c. Clean up conduit threads at exposed conduit ends using a wire brush.
    d. Treat minor surface rust with a cleaning agent and apply zinc, rust inhibiting coating to the damaged area.

3.03 RACEWAY SPECIFICATION (RACESPEC) SHEETS

A. The following RACESPECs are included in this section:

RACESPEC Symbol	Raceway Description
FLEX	Flexible steel conduit
GRS	Rigid steel conduit
LFS	Liquidtight flexible steel conduit
PRS	PVC coated rigid steel conduit
PVC40	Schedule 40 PVC conduit
PVC80	Schedule 80 PVC conduit
RAC	Rigid Aluminum Conduit
SS	Rigid stainless steel conduit
WW	Wireway and auxiliary gutter

Raceway Identification:	FLEX
Description:	Flexible steel conduit.
Application:	Final connection to lighting fixtures in architecturally finished areas only.
Compliance:	UL 1.
Construction:	Spirally-wound galvanized steel strip with successive convolutions securely interlocked.
Minimum Size:	1/2 inch.
Fittings:	Compression type.
Other:	FLEX shall be provided with an internal ground wire.
Installation:	Flexible steel conduit shall be made up tight and with conductive “coppershield” thread compound.

Raceway Identification:	GRS
Description:	Rigid steel conduit.
Compliance:	ANSI C80.1, UL 6.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., or approved equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Hubs: Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or approved equal.
Unions:	Electrogalvanized ferrous alloy type Appleton UNF or UNY, Crouse Hinds UNF or UNY, or approved equal. Threadless fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6-inches square. NEMA 12 welded steel 6-inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight. Conduit Bodies: Ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
Outdoor:	Type FD cast ferrous for all devices and for junction boxes less than 6-inches square. NEMA 4X stainless steel for 6-inches square and larger.
Corrosive:	NEMA 4X stainless steel.
Hazardous:	NEMA Class 7 cast ferrous.
Elbows:	
3/4 through 1-1/2 Inches:	Factory fabricated or field bent.
2 through 6 Inches:	Factory fabricated only.
Conduit Bodies:	
3/4 through 4 Inches:	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
5 Inch and 6 Inch:	Electrogalvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
Manufacturers:	Appleton, Crouse-Hinds, Hubbell, O.Z. Gedney, or approved equal.
Installation:	Rigid steel conduit shall be made up tight and with conductive “coppershield” thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot dip galvanized malleable iron straps with nesting backs.

Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.
Exposed male threads or rigid steel conduit shall be coated with zinc-rich paint.

Raceway Identification:	LFS
Description:	Liquidtight flexible steel conduit.
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360.
Construction:	Spirally-wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum Size:	3/4 inch.
Fittings:	
General:	Watertight, outdoor and wet rated. Grounding ferrule shall be threaded to engage conduit spiral. Provide O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90 degree fittings shall be used where applicable.
Dry Locations:	Material: Cadmium-plated malleable iron body and gland nut with cast-in lug, brass.
Wet, Outdoor or Corrosive Locations:	Material: Stainless steel.
Installation:	The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches. Liquidtight flexible steel conduit shall be made up tight and with conductive “coppershield” thread compound.

Raceway Identification:	PRS
Description:	Rigid steel conduit, corrosion-resistant, polyvinyl chloride (PVC) coated.
Compliance:	ANSI C80.1, UL 6, NEMA RN1.
Finish:	PRS shall be hot dipped galvanized rigid steel conduit. The inside and outside, as well as the threads shall be galvanized. A minimum 40-mil thick PVC coating shall be bonded to the outside of the conduit and the inside shall be coated with 2-mil urethane. Coating shall be free of pinholes. Bending of conduit shall not damage either the interior or exterior coating. Bond strength shall exceed the tensile strength of the PVC coat. Elbows shall be factory made and coated.
Minimum Size:	3/4 inch.
Fittings:	Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. A 2-mil urethane coating shall be applied to the interior, and the threads of all fittings and couplings. Conduit and fittings shall be manufactured by the same company.
Hubs:	Hubs for connection of conduit to junction, device, pull, or terminal boxes shall be threaded and made of cast ferrous alloy. Hubs shall be galvanized steel and have insulating bushings. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection.
Boxes:	
Nonhazardous:	NEMA 250, Type 4X stainless steel.
Hazardous:	NEMA 250, Type 7D cast ferrous.
Installation:	PVC-coated conduit shall be supported away from the structure using PVC-coated conduit wall hangers. All conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer’s recommendations. Plastic coated conduit shall be made tight with special wrenches and fittings designed for tightening PVC-coated conduit. All threads shall be protected against corrosion per NEC 300.6 (a) by liberally applying an approved electrically conductive, corrosion resistant compound – “coppershield”. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas, including threads, shall be patched, using manufacturer’s recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.

Raceway Identification:	PVC40
Description:	Rigid nonmetallic polyvinylchloride conduit for normal duty applications including direct burial.
Compliance:	NEMA TC2, UL 651.
Construction:	Schedule 40, polyvinylchloride (PVC).
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased.
Fittings:	PVC solvent weld type.
Boxes:	
Indoor:	NEMA Class 4, nonmetallic.
Outdoor and Corrosive:	NEMA Class 4X, nonmetallic.
Installation:	Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch 5 feet apart for conduits 1-1/4 inches to 2 inches and 6 feet apart for conduits 2-1/2 inches and larger. PVC conduit shall not be provided where it will be damaged by heat. PVC conduit shall have bell ends where terminated at walls.

Raceway Identification:	PVC80
Description:	Rigid nonmetallic conduit, extra heavy wall thickness for all locations including direct bury under roadways and where exposed to physical damage.
Compliance:	NEMA TC2, UL 651.
Construction:	Schedule 80, high-impact, polyvinylchloride (PVC).
Minimum Size:	3/4 inch exposed; 1 inch embedded or encased.
Fittings:	PVC solvent weld type.
Boxes:	
Indoor:	NEMA Class 4, nonmetallic.
Outdoor and Corrosive:	NEMA Class 4X, nonmetallic.
Installation:	Exposed PVC conduit shall be run on supports spaced not more than 3 feet apart for conduits up to 1 inch 5 feet apart for conduits 1-1/4 inches to 2 inches and 6 feet apart for conduits 2-1/2 inches and larger. PVC conduit shall not be provided where it will be damaged by heat. PVC conduit shall have bell ends where terminated at walls.

Raceway Identification:	RAC
Conduit:	
Description:	Rigid Aluminum Conduit manufactured from 6063 alloy with T 1 temper.
Finish:	Corrosion resistant aluminum.
Compliance:	UL6A, ANSI C80.5, WW-C-540c.
Construction:	Corrosion resistant aluminum
Manufacturer:	Allied Tube and Conduit Corp., Wheatland Tube Co., or approved equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Elbows:	
3/4 through 1 Inch:	Factory fabricated or field bent with approved bender.
1-1/2 through 4 Inch:	Factory fabricated only.
Fittings:	
Conduit Bodies:	
Material/Finish:	Cast copper-free aluminum.
Size:	3/4 inch through 4 inch.
Cover:	Stamped, domed top, copper-free aluminum with neoprene gasket. Stainless steel screws. Conduit body with gasketed cover shall be outdoor, raintight, wet location rated.
Compliance:	UL514B, Fed spec W-C-586D, NEMA FB-1.
Hubs:	Watertight, gasketed, copper-free aluminum, insulated throat with ground screw.
Unions:	copper-free aluminum type Appleton UNF or UNY, Crouse Hinds UNF or UNY, or approved equal. Threadless fittings are not acceptable.
Conduit Seals:	Copper-free aluminum, Type EYSX.
Manufacturers:	Crouse-Hinds, O.Z. Gedney, or approved equal.
Boxes:	
Indoor/Dry Locations:	Locations which are both indoor and dry.
Less than 6 in. sq.:	Type FD copper-free aluminum for all device boxes. Copper-free aluminum covers with stainless steel screws. Gasketed, watertight, wet-rated for process areas.
6 in. sq. and larger:	NEMA 12 rated, welded copper-free aluminum with hinged door and clamp lock. Boxes within process areas shall be NEMA 4 welded copper-free aluminum.
Outdoor Locations:	
Less than 6 in. sq.:	Type FD copper-free aluminum for all device boxes. Copper-free aluminum covers with stainless steel screws. Gasketed, watertight, wet-rated.
6 in. sq. and larger:	NEMA 4 rated, welded copper-free aluminum with hinged door and clamp lock.
Manufacturers:	Crouse-Hinds, O.Z. Gedney, or approved equal.
Hazardous Areas:	Copper-free aluminum, NEMA 7, Explosionproof, raintight and wet location rated.

Installation:	Aluminum conduit shall be made up tight and with approved, conductive “Aluminum Antioxidant Joint Compound”. Joints shall be made with standard couplings or threaded unions. Where not shown on Drawings, support RAC and associated components using stainless steel supports which include a non-conductive barrier between the stainless steel and the aluminum to prevent galvanic corrosion. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Aluminum conduit is not to be installed in concrete or soil unless shown on the Drawings. For aluminum conduit that is installed in concrete or in contact with soil, supplementary corrosion protection, such as paints or wraps approved for the purpose, is required.

Raceway Identification:	SS
Description:	Rigid stainless steel conduit.
Compliance:	ANSI C80.1, UL 6.
Material:	316 stainless steel.
Manufacturers:	Calbrite, Wheatland Tube Co., or approved equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Hubs: bonding locknut, 316 stainless steel. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection.
Unions:	316 stainless steel. Threadless fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast 316 stainless steel for all device boxes and for junction boxes less than 6-inches square. NEMA 12 welded steel 6-inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4X watertight. Conduit Bodies: 316 stainless steel type with screw taps for fastening covers. Gaskets shall be made of neoprene.
Outdoor:	Type FD cast 316 stainless steel for all devices and for junction boxes less than 6-inches square. NEMA 4X stainless steel for 6-inches square and larger.
Corrosive:	NEMA 4X stainless steel.
Hazardous:	NEMA Class 7 cast 316 stainless steel.
Elbows:	
3/4 through 1-1/2 Inch:	Factory fabricated or field bent.
2 through 6 Inch:	Factory fabricated only.
Conduit Bodies:	
3/4 through 4 Inch:	316 stainless steel. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
Installation:	Rigid stainless steel conduit shall be made up tight and with conductive “coppershield” thread compound. Joints shall be made with standard couplings or threaded unions. Rigid stainless steel conduit shall be supported away from the structures using hot dip galvanized malleable iron straps with nesting backs. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Galvanic isolation.

Raceway Identification:	WW
Description:	Wireway and auxiliary gutter, flanged, oiltight type with hinged covers.
Compliance:	JIC EMP-1.
Minimum Size:	8-inch by 8-inch.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces. Paint with factory standard finish.
Application:	As indicated on the Drawings.

END OF SECTION

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings and product data.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. All work shall be performed by craftsmen skilled in their trade. All work shall present a neat, finished appearance.

B. Install all equipment in strict accordance with the manufacturer's instructions unless directed otherwise.

C. Slope all underground conduits or ducts to provide drainage to a pull box.

D. After completing an underground conduit or duct run, prove the integrity of the run by pulling through it a mandrel 1/4 inch smaller than the inside diameter of the raceway.

E. In each manhole, handhole, pull box, cabinet, motor control center, or other equipment enclosure, identify each conduit and duct using the conduit number shown on the Drawings by means of a stamped brass tag affixed with stainless steel wire. Where affixing tag is not feasible, identify conduits by stenciling. Stencil each exposed conduit for identification at least once in each room.

3.02 UNDERGROUND ELECTRIC WORK

A. Duct Banks:

1. Thoroughly clean conduits before laying. During construction and after completion, plug conduit ends to prevent dirt and mud from entering the duct or manholes.

2. Lay duct lines to a minimum grade of 4 inches per 100 feet. Grade may be from manhole to manhole or from a highpoint between manholes. Slope all conduit to drain to manholes or pull boxes.

3. Terminate conduit in end bells in manholes.

4. Changes in direction of over 10 degrees shall be with long sweep bends. Manufactured bends may be used at the manholes for runs under 100 feet. Minimum radii for conduit under 3 inches shall be 18 inches. For conduit 3 inches and larger, minimum radii shall be 36 inches.

5. Place separator spacers every 4 feet on centers and securely anchor to prevent movement.

6. Encase duct banks carrying medium voltage circuits in reinforced red concrete where shown on Drawings. All conduit joints shall be staggered by at least 6 inches. Reinforce duct bank with minimum No. 4 size bar. Place at least 3 inches of concrete on all sides of the conduit.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of labels, nameplates, and markers used to identify electrical system equipment and components.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Nameplate Schedules.

PART 2 - PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Provide nameplates on all new and Owner-furnished equipment.

B. Panel Nameplates (Major Equipment): For equipment such as switchgear, variable frequency drive (VFD) panels, motor starter panels, control panels, electrical equipment enclosures, disconnect switches, motors, and pumps, the nameplates shall be:

1. Located on the enclosure face.
2. Rectangular screw-on type with self-tapping 316 stainless steel screws.
3. Laminated phenolic plastic nameplate, 1.25-inch-tall, with white letters on black backgrounds. Length as required.
4. Lettering: 1/2-inch-high lettering for equipment name with 1/2-inch-high lettering for tag or equipment number.
5. Nameplate text shall include:
    a. Line 1: Descriptive name (e.g., “Secondary Clarifier 7 RAS Pump 1”).
    b. Line 2: Descriptive tag (e.g., “46P1801”).

C. Enclosure Nameplates (Minor Equipment): For equipment such as local control stations, instrument transmitters, analytical controllers, and terminal boxes, the nameplates shall be:

1. Located on the enclosure face.
2. Adhesive-backed, 1-inch-tall, laminated phenolic plastic nameplate with white letters on black backgrounds. Length as required.
3. Lettering: 3/8-inch-high lettering for descriptive tag.
4. Nameplate text shall include:
    a. Line 1: Descriptive name (e.g., “Secondary Clarifier 7 RAS Pump 1”).
    b. Line 2: Descriptive tag (e.g., “46FIT1801” or “46LCP1801”).

D. Component Nameplates - Panel Face: For component identification located on panel face under or near component, the nameplates shall be:

1. Adhesive-backed, 1/2-inch-tall, laminated phenolic plastic nameplate with white letters on black backgrounds. Length as required.

2. Lettering: 3/16-inch-high lettering.

E. Component Nameplates - Back of Face: For component identification located on or near component inside of enclosure, the nameplates shall be:

1. Adhesive-backed, 1/2-inch-tall, laminated phenolic plastic nameplate with white letters on black backgrounds. Length as required.

2. Lettering: 3/16-inch-high lettering.

F. Nameplate schedule shall be included with all equipment submittals.

2.02 WIRE MARKERS

A. Identify each power and control conductor at each end of each terminal to which it is connected. Include identification for each spare conductor.

B. Conductors size No. 10 AWG or smaller shall have identification sleeves:

1. Machine print on sleeves with permanent black ink the letters and numbers that identify each wire.

2. Figures: 1/8 inch high.

3. Sleeves: White tubing, sized to fit the conductor insulation.

4. The sleeves shall be shrunk to fit the conductor with hot air after installation.

5. Acceptable Manufacturer:

a. TMS Thermofit Marker System by Raychem Co.

b. Sleeve style wire marking system by W. H. Brady Co.

c. Approved equal.

6. Adhesive strips are not acceptable.

C. Use cable markers of the locking tab type for conductors No. 8 AWG and larger:

1. Tabs: White plastic with conductor identification number permanently embossed.

2.03 RACEWAY NUMBERING SYSTEM

A. General:

1. Identify each conduit; rack and tray shall be identified by a unique number shown on the Drawings.

B. Conduit Identification Tag:

1. Pressure stamp conduit numbers into a non-corrosive metal tag. Fix a tag with number to each end of each conduit and at each manhole, pullbox, and handhole with Type 304 Stainless Steel wire.

PART 3 - EXECUTION

3.01 GENERAL

A. Label all new and Owner-furnished electrical and control equipment.

3.02 CONDUCTOR IDENTIFICATION

A. Identify each wire or cable at each termination and in each pull box, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall

have the same number. Each electrically-different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.

B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

C. Conductors No. 8 and smaller shall be identified by printed sleeve of the heat-shrink type. All such sleeves shall be shrunk to the conductor insulation.

D. Contractor is responsible to identify every termination at this site except for light switch and outlet terminations, whether Contractor terminated them or terminations were made by others.

E. It shall not be required to identify equipment ground wires except by green color.

3.03 SWITCH AND OUTLET BOXES

A. Label light switches and outlets with panel name and circuit number.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide the services of a recognized independent testing laboratory or coordination analysis consultant who is regularly engaged in power system studies to provide the following reports:

1. Short Circuit Report.
2. Protective Device Coordination Report.
3. Arc Flash Report.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. Procedures: As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Provide separate submittal for each project site/location.

C. Submit the name and the qualifications of the laboratory or consultant for review by the Engineer. Qualifications must include professional registration of proposed personnel as electrical engineers.

D. Certified Short Circuit, Coordination, and Arc Flash Reports: Submit prior to the start of manufacture of equipment included in the scope of the Short Circuit, Coordination, and Arc Flash Reports. Provide correction(s) to report(s) as necessary to accommodate changes to equipment configuration and/or components.

E. Arc flash warning labels: Submit no less than 6 weeks prior electrical equipment commissioning.

PART 2 - PRODUCTS

2.01 SHORT CIRCUIT, COORDINATION, AND ARC FLASH REPORTS

A. Scope of Effort:

1. Perform the studies using actual equipment data. Existing as-built electrical drawings of the facilities may exist but the accuracy of those drawings cannot be confirmed by the Owner. The testing laboratory should assume that field investigations will be required to gather all information for the reports.
2. Short Circuit, Coordination, and Arc Flash Reports to be stamped and signed by an electrical Engineer registered in the State of Washington.
3. The reports shall include:
    a. All equipment shown on the one-line diagrams and the associated feeder breakers from the existing distribution panels. Include the existing utility service, standby generator source, utility and generator main circuit breakers as well as other electrical distribution system components which may be necessary to provide a complete short circuit, coordination, and arc flash report for this project.

B. Coordination Objective:

1. The protective device on the line side closest to the fault or abnormal conditions shall isolate the problem portion of the system and minimize damage in that portion. The rest of

the system shall be maintained in normal service. The coordination shall be in conformance with the recommendations of latest IEEE Standard 242.

2. Use the circuit breaker manufacturer's selective coordination tables to determine coordination in the instantaneous trip region.

C. Report Submittals:

1. Schedule:

a. Submit Short Circuit, Coordination, and Arc Flash Reports with equipment submittals.

b. Provide and install arc flash labels prior to commissioning.

2. Submit the analysis, which shall include impedance and short-circuit calculations, list of any assumptions made in the analysis, the recommended settings of the protective devices, and the system time/current characteristic curves. The submittal shall be made so as to allow time for review and resubmittal, if necessary, before the implementation of final settings and adjustments by the testing laboratory.

3. Short Circuit Report: As a minimum, include the following in the report:

a. Executive summary.

b. Equipment manufacturer's information used to prepare the study.

c. Assumptions made during the study.

d. Short circuit calculations listing short circuit levels at each bus.

e. Evaluation of the electrical power system and the model numbers and settings of the protective devices associated with the system.

f. Time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.

g. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment connected to that bus.

4. Protective Device Coordination Report: As a minimum, include the following on 5 cycle, log-log graph paper:

a. Time-current curve for each protective relay or fuse showing graphically that the settings will allow protection and selectively within Industry standards. Identify each curve and specify the tap and time dial setting.

b. Time-current curves for each device to be positioned for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, notify the Project Representative as to the cause.

c. Time-current curves and points for cable and equipment damage.

d. Circuit interrupting, device operating, and interrupting times.

e. Indicate maximum fault values on the graph.

f. Sketch of bus and breaker arrangement.

5. Arc Flash Report: As a minimum, include the following in the report:

a. Equipment manufacturer's information used to prepare the study.

b. Assumptions made during the study.

c. Reduced copy of the one line Drawing.

d. Arc flash evaluations summary spreadsheet including:

1) Bus name.

2) Upstream protective device name, type, settings.

3) Bus line to line voltage.

4) Bus bolted fault.

5) Protective device bolted fault current.

6) Arcing fault current.

7) Protective device trip/delay time.

8) Breaker opening time.

9) Solidly grounded column.

10) Equipment type.

11) Gap.

12) Arc flash hazard protection boundary.

13) Working distances.

14) Incident energy.

15) Required protective fire rated clothing type and class.

e. Bus detail sheets.

f. Arc flash warning labels printed in color on adhesive-backed labels.

1) Arc flash warning labels are to be produced and attached to each piece of electrical equipment included in the scope of these reports.

2) These labels must indicate approach boundaries, incident energy level, and the minimum PPE that is required when servicing the equipment within the arc flash boundary.

3) Labels shall be installed by Contractor on associated equipment.

PART 3 EXECUTION

3.01 GENERAL

A. Perform the studies in accordance with:

1. IEEE Standards 141, 242, and 1584.

2. NFPA 70E.

3. OSHA 29-CFR, Part 1910 Subpart S.

B. Perform the studies using actual equipment data.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of junction boxes for consolidation of conduit runs, pull boxes to aid in pulling conductors, and outlet boxes for wiring devices, lighting fixtures, and signal equipment.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Shop Drawings and product data.

PART 2 - PRODUCTS

2.01 OUTLET BOXES

A. Sheet Metal Boxes:

1. Sheet metal boxes shall conform to UL 50, with a hot-dipped galvanized finish conforming to ASTM A 123.

2. Outlet boxes and switch boxes shall be designed for mounting flush wiring devices. Boxes and box-extension rings shall be provided with knockouts. Boxes shall be formed in one piece from carbon steel sheets. Outlet boxes shall not be less than 4-inches square and 1-1/2-inches deep.

3. Ceiling boxes shall withstand a vertical force of 200 pounds for 5 minutes.

4. Wall boxes shall withstand a vertical downward force of 50 pounds for 5 minutes.

5. Gangable and through-wall types are not acceptable.

6. Boxes shall conform to FS W-J-800D and UL 514A and UL 514C.

B. Cast Metal Boxes:

1. Box bodies and cover shall be cast or malleable iron with a minimum wall thickness of 1/8 inch at every point, and not less than 1/4 inch at tapped holes for rigid conduit. Bosses are not acceptable.

2. Mounting lugs shall be provided at the back or bottom corners of the body.

3. Covers shall be secured to the box body with No. 6 or larger brass or bronze flathead screws.

4. Boxes shall be provided with neoprene cover gaskets.

5. Where only cast aluminum is available for certain types of fixture boxes, an epoxy finish shall be provided.

6. Outlet boxes shall be of the FS types. Boxes shall conform to FS W-C-586C, UL 514A, and UL 514C.

2.02 TERMINAL CABINETS:

A. Terminal cabinets located indoors shall be NEMA 4.

B. Cabinets located outdoors and in corrosive areas shall be NEMA 4X, stainless steel.

C. Cabinets shall be provided with hinged doors.

D. Adjustable terminal strip mounting accessories shall be provided.

E. Cabinets shall be provided with channel mounted terminal blocks rated 30 A, 600 Vac.

F. Terminals shall be No. 8 minimum strap-screw type, suitable for ring tongue or locking spade terminals.

2.03 ENCLOSURES

A. Unless otherwise noted, provide enclosures as follows:

1. Dry Locations: NEMA Type 1.
2. Wet Locations (outdoor, non-hose down): NEMA Type 4X, stainless steel.
3. Wet Locations (subject to hose down, chemical storage, and loading areas): NEMA Type 4 or better.
4. General Process Areas (subject to hose down): NEMA Type 4 or better for equipment installed at or below 6 feet above finished floor, NEMA Type 12 or better for equipment installed higher than 6 feet above finished floor.
5. Damp Locations: NEMA Type 12.
6. Corrosive Locations: NEMA Type 4X, Stainless Steel.
7. Hose down locations include those locations likely to be cleaned or washed during normal operations. These locations include chemical storage and loading areas and other areas where hose bibs are installed to facilitate hose down.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide fixture outlets with proper fixture connectors.

B. Box mounting height shall be dictated by the wiring device enclosed.

C. Blanking covers shall be installed on all unused openings.

D. Sheet metal boxes shall be used in dry noncorrosive locations where the conduit system is routed concealed in the walls and ceilings.

E. Cast metal or molded nonmetallic surface-mounted boxes shall be used in exterior and/or in all wet locations.

F. Bonding jumpers shall be used around all concentric or eccentric knockouts.

G. Boxes shall be securely mounted to the building structure independent of conduits entering or exiting the boxes.

H. No top conduit entry for outdoor enclosures, damp or wet locations, or for NEMA 3R, 4 and 4X enclosures.

I. Provide nameplates and labels for cabinets and enclosures.

J. Grounding of cabinets and enclosures shall comply with the NEC.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of:

1. Single, duplex, GFI, and special purpose receptacles complete with wall plates and/or covers.

2. Single-pole, three-way, pilot lights, and momentary position toggle switches complete with wall plates and/or handle operators.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Shop drawings and product data.

PART 2 - PRODUCTS

2.01 RECEPTACLES

A. General: Receptacles shall be specification grade, heavy-duty, high-abuse, grounding type conforming to NEMA configurations, NEMA WD1, and UL 498 Standards.

B. Single and Duplex Receptacles:

1. Receptacles shall be of back and side wire design utilizing screw-type terminals. Receptacles shall be rated 20 A, two-pole, three-wire, 120 V, NEMA 5-20 configuration, self-grounding. Color shall be brown in industrial areas and ivory or white in office and laboratory areas. Power contacts shall be a T-type design and shall be brass. Ground contacts shall be brass.

2. Devices shall have a nylon composition face with a nylon or melamine body. Units shall comply with Federal Specification W-C-596E and meet UL 498 test requirements. Receptacles shall be Hubbell HBL5362, or approved equal.

C. Special Purpose Receptacles: Receptacles shall be of the amperage, voltage, and NEMA configuration indicated on the Drawings. Compliance to standards and tests shall be as listed in Item B above.

D. GFI Receptacles:

1. Device shall be rated 20 A, two-pole, three-wire, 120 V, conforming to NEMA WD1.10 configuration. Face shall be nylon composition meeting UL 498 test standards. Unit shall have test and reset push buttons and LED indicator.

2. GFCI component shall meet UL 943 Class A standards with a tripping time of 1/40 second at 5 mA current unbalance. Operating range shall extend from 31 degrees F to 158 degrees F. Unit shall have transient voltage protection and shall be ceramic encapsulated for protection against moisture.

3. Provide Hubbell GF20, Eaton, or approved equal.

E. Surface Multiple-Outlet Assemblies: Units shall have outlets on center-to-center spacing as indicated on the Drawings. Assembly shall conform to Article 353 of the NEC and receptacles shall conform to the standards listed in Item A above.

2.02 SWITCHES

A. Line-Voltage Types: Switches shall be rated 20 A at 120 V or 277 V, ac only. Units shall be flush-mounted, self-grounding, quiet-operating toggle devices. Handle color shall be brown in industrial areas and white or ivory in office and laboratory areas. Units shall conform to Federal Specifications W-S-896 D and E, UL 20-11 and UL 20-2, and NEMA WD1 Standards. Hubbell HBL1221, Eaton, or approved equal.

B. Low-Voltage Types: Switches shall meet all of the requirements listed in Item A above except to be rated at 15 A for switching 24 Vdc. Devices shall be three-position, momentary-contact, spring-return, center “off” configuration.

C. Manual Motor Starters: For 120 V, single-phase motors that require a lockable disconnect, provide a padlockable manual motor starter without overloads.

2.03 PLATES AND COVERS

A. General: Plates shall be of the style and color to match the wiring devices, and of the required number of gangs. Plates shall conform with NEMA WD1, UL 514, and ANSI C73. Plates on finished walls shall be nonmetallic or stainless steel. Plates on unfinished walls and on fittings shall be of zinc-plated steel or cast metal having rounded corners and beveled edges.

B. Nonmetallic: Plates shall be smooth finish with contoured edges and shall be nylon or fiberglass.

C. Stainless Steel: Plates shall be 0.035 inches thick with beveled edges and shall be manufactured from No. 302 alloy having a brushed or satin finish.

D. Galvanized: Plates shall be galvanized sheet steel raised 1/2 inch, with rounded corners.

E. Cast Metal: Plates shall be cast or malleable iron covers with gaskets so as to be moisture resistant or weatherproof.

F. Blank Plates: Cover plates for future telephone or television outlets shall match adjacent device wall plates in appearance.

G. Damp or Wet and Corrosive Locations: Plates shall have weather protective double doors. Material of manufacture shall be die-cast aluminum for metallic plates or nylon for nonmetallic plates.

H. Outdoor Locations: While-in-use style weatherproof cover, cast metal while-in-use cover, padlockable in the closed position, Hubbell, Eaton, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

A. Dry Locations: The device shall be installed in flush-mounted boxes with washers as required to bring the device mounting strap level with the surface of the finished wall.

B. Damp or Wet Exterior Locations: Install only wiring devices approved for outdoor service in these locations.

C. Mounting Heights:

1. Locations of wall outlets shall be measured from the finished floor to the center of the outlet box. Boxes shall be adjusted so that the front edge of the box shall not be further back from the finished wall plane than 1/4 inch. Boxes shall be adjusted so that they do not project beyond the finished wall. Height above finished floor shall be as follows:

a. Telephone Outlets - Office Areas: 12 inches from floor.

b. Telephone Outlets - Industrial Areas: 60 inches from floor.

c. Duplex Receptacles - Office Areas: 12 inches from floor.

d. Receptacles - Industrial Areas: 46 inches from floor.

e. Toggle Switches: 46 inches from floor.

f. Clock Outlets: 84 inches from floor.

D. Damp or Wet Interior Locations:

1. Install only wiring devices approved for outdoor service.

2. Adjust boxes so that front edge will be 1/4 inch beyond the rear edge of the finished wall.

3. Use metal tubing sleeves to bring device-mounting straps flush with the front edge of the finished wall.

E. Receptacles:

1. Receptacles shall be grounded by a grounding conductor, not by a yoke or screw contact.

2. Receptacles shall be oriented so that the grounding slot is located at the top of the outlet.

3. Receptacles shall be installed with connections pigtailed (spliced) to the branch circuit wiring so that removal of the receptacle will not lose neutral continuity and branch circuit power will not be lost to other receptacles on the same circuit.

3.02 INSTALLATION OF WALL PLATES

A. General: Plates shall match the style of the device and shall be plumb within 1/16 inch of the vertical or horizontal.

B. Interior Dry Locations: Install plates so that all four edges are in continuous contact with the finished wall surfaces. Plaster filling will not be permitted. Do not use oversize plates or sectional plates.

C. Exterior and/or Wet Locations: Install plates with gaskets on wiring devices in such a manner as to provide a rain-tight weatherproof installation. Cover type shall match box type.

D. Future Locations: Install blanking cover plates on all unused outlets.

3.03 TESTS

A. Receptacles:

1. Receptacles shall be tested for blade and ground-plug tension prior to installation. Do not install any receptacle having less than 16-ounce individual blade retention.

2. After installation of receptacles, circuits shall be energized and each receptacle tested for proper ground continuity, reversed polarity, and/or open neutral condition.

B. GFI receptacles shall be tested with the circuits energized. Devices shall be tested with a portable GFI receptacle tester capable of circulating 7.5 mA of current, when plugged in, between the “hot” line and “ground” to produce tripping of the receptacle. Resetting and tripping shall be checked at least twice at each GFI receptacle.

END OF SECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for furnishing, installation, and connection of overcurrent protective devices.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. As specified in Section 26 05 00 - Common Work Results for Electrical.

B. Shop Drawings and product data.

PART 2 - PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKERS

A. General:

1. Comply with UL 489 requirements.
2. Provide thermal and magnetic protection.

B. Provide permanent trip lighting panel circuit breakers as follows:

1. UL listed SWD (switching duty) on 120 V circuits where switched circuits are indicated.
2. Short circuit rating (integrated equipment rating):
    a. Up to 240 V: 10,000 RMS symmetrical amps minimum, or as required per the short circuit, coordination, and arc flash report.
    b. Up to 480 V: 14,000 RMS symmetrical amps minimum, or as required per the short circuit, coordination, and arc flash report.

C. Where enclosed circuit breakers are required, provide with:

1. Cover interlock.
2. Handle position that indicates ON, OFF, or TRIPPED.
3. Padlock provision in the OFF position.
4. External trip indication.
5. Provision for insulated or bonded neutral.
6. Provision for control circuit interlock.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install overcurrent protective devices in accordance with manufacturer’s recommendations.

B. Grounding of safety disconnect switches shall comply with the NEC.

3.02 ADJUSTMENT

A. Set and record adjustable settings on circuit breakers to provide selective coordination and proper operation.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Perform all dewatering and storm drain redirect necessary or required for the construction of the Work as covered by these Specifications and indicated on the Drawings.

B. Contractor is responsible to plan, schedule and sequence activities to ensure that storm drain redirect operations at all times is uninterrupted and performed in accordance with the Washington State Department of Ecology Stormwater Manual for Western Washington, the Stormwater Pollution Prevention Plan (SWPPP), and all applicable regulations.

C. Bypassing stormwater directly to surface waters without adequate treatment is prohibited. Penalties, legal fees, or other expenses imposed on the Owner resulting directly or indirectly from any bypass caused the Contractor shall be borne in full by the Contractor.

1.02 RELATED SECTIONS

A. Section 31 23 33 - Earthwork.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Submittal Procedures.

B. Submit a Dewatering Work Plan stamped by a Professional Engineer licensed in Washington State. The Work Plan shall include drawings and complete design data showing methods and equipment for dewatering necessary to keep excavations and pipe trenches dry during construction. At a minimum, include the following:

1. Drawings indicating the location and size of berms, dikes, ditches, sumps, and vacuum and discharge lines.

2. Capacities of primary pumps and standby equipment.

3. Design calculations providing adequacy of the system and selected equipment, including estimated water volumes.

4. Detailed description of the dewatering schedule, operation, maintenance, and removal procedures.

5. If required, a detailed description of the excavation groundwater treatment system suitable for the anticipated discharge water quality at each site. Discharge shall meet applicable regulatory requirements.

6. List all permits required for dewatering and disposing of the dewatering discharge.

C. Submit a drainage redirect plan detailing discharge locations and method of conveyance.

1.04 QUALITY ASSURANCE (NOT USED)

1.05 SUBSURFACE INVESTIGATIONS

A. Geotechnical investigations conducted for this project are available for review per Section 00 31 00 Available Project Information.

1.06 STORM DRAIN REDIRECT

A. The existing storm system shall be maintained in operation through the use of existing or temporary systems, except as specified herein, until the new facilities are accepted by the Engineer and capable of accepting stormwater.

B. The Contractor shall execute work in such a way that maintenance and operation of the storm system can be normally operated. Access to the facilities shall be provided at all times; switch-over to the new facilities shall be fully coordinated with the Engineer.

C. Minimum System Requirements: Through the use of permanent or temporary facilities, the Contractor shall maintain system capacity for all anticipated storm events.

1. Redundancy: Contractor shall provide on site, and installed ready for operation, a complete redundant pump equal to or larger than the largest pump in the system used to provide the specified maximum pumping capacity.

2. Backup Power: If the maximum pumping capacity is being provided by electric motor drive pumps, an engine-driven generator or standby pump shall be provided and installed ready for operation

D. Any discharge of untreated dewatering water to surface waters is prohibited. Penalties imposed on the Owner as a result of any bypass caused by the Contractor or subcontractors, and legal fees and other expenses to the Owner resulting directly or indirectly from the bypass shall be borne in full by Contractor.

1.07 SURFACE WATER DRAINAGE CONTROL

A. The Contractor shall be responsible for controlling surface water drainage in accordance with the SWPPP and Section 01 57 13 for keeping excavations and other areas free from entry of surface water to prevent damage to the Work.

B. The Contractor's operations and surface water management shall be conducted in such a manner as to prevent sediment from reaching the existing storm drain or local waterways.

C. The Contractor shall cover exposed excavated areas and soil or material stockpiles when runoff from rain is likely to cause turbid waters to enter waterways or drainage systems.

D. The Contractor shall suspend work in the rain if the work cannot be performed without causing turbid runoff.

E. Material stockpiles shall be place on and covered with clear 6-mil polyethylene sheeting at all times when not is use to prevent contact with rain.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONTROL OF WATER

A. There is a potential for regulated materials in groundwater to be encountered during construction, therefore the dewatering approach implemented by the Contractor shall minimize the amount of pumping required.

B. All excavations shall be kept free from water and all construction shall be in the dry.

1. It should be presumed that the presence of groundwater will require dewatering operations. Furnish, install, maintain, and operate all necessary pumping and other equipment for dewatering all excavations. At all times have on the project sufficient pumping equipment for immediate use, including standby pumps for use in case primary pumps are insufficient or become inoperable.

2. Provide a sufficient number of pumps so as to hold the groundwater level at an elevation of not less than 2 feet below the lowest elevation of the pipe, duct, structure or other material to be placed.

3. Dispose of water in such a manner as to cause no injury or nuisance to public or private property, or be a menace to the public health. The Contractor shall:
    a. Obtain permits for dewatering disposal as necessary and comply with all permit requirements.
    b. Furnish all piping, pumps and other required equipment for dewatering operations.
    c. Treat dewatering discharge for sediment, color, or other materials as required by the applicable permits.
4. Begin pumping for dewatering in advance of excavation to ensure that water drains out of the soil column and that soil pore pressure is relieved.
5. The dewatering operation shall be continuous, so that the excavated areas shall be kept free from water during construction, while concrete is setting and achieves full strength, and until backfill has been placed to a sufficient height to anchor the work against possible flotation.
6. Continue dewatering during backfilling operations such that groundwater is at least 2 feet below the level of the compaction effort at all times. No compaction of saturated materials will be allowed.
7. Dewatering devices must be adequately filtered to prevent the removal of fines from the soil.
8. The Contractor shall be responsible for all damage to foundations or any other parts of existing structures or of the new work caused by failure of any part of the Contractor's protective works. After temporary protective works are no longer needed for dewatering purposes, they shall be removed by the Contractor.
9. If pumping is required on a 24-hour basis, requiring engine drives, then engines shall be equipped in a manner to keep noise to a minimum. Refer to Section 01 50 00 for noise control requirements.
10. Prevent disposal of sediments from the soils to adjacent lands or waterways by employing whatever methods are necessary.

3.02 REGULATED MATERIALS IN GROUNDWATER

A. Contractor shall monitor groundwater by instructing workers in observing and reporting suspicious materials. Indicators of suspicious materials include but are not limited to refuse, odors, oily sheen or color on soils and water, and oily or chemical odors. If unexpected suspicious materials are encountered, Contractor shall stop work in that area immediately and notify the Engineer.

B. Groundwater removed from excavations that exhibits characteristics included in 3.02A above shall be stored in on site tanks provided by the Contractor. The Contractor shall notify the Engineer when pumping and storage of groundwater begins.

C. The Owner will characterize the stored water. The Contractor shall allow 21 days for testing.

D. The Contractor shall record in gallons the total quantity of groundwater stored and if applicable, discharged. This can be done by metering the flow or calculating batch discharges based on the volume of the storage tanks. The discharge location will be determined by the Engineer and the Contractor shall be responsible for procuring required permits if needed.

3.03 STORM DRAIN REDIRECT

A. The Contractor shall divert all flows around each segment of pipe designated for replacement. The diversion shall consist of redirecting flow from an upstream manhole and discharging it to a manhole downstream of the replacement operation.

B. Re-directed storm drain flows shall be treated as necessary prior to discharging to the downstream storm drain system.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Perform all excavation, shoring, dewatering, backfilling, compaction and grading necessary or required for the construction of the work as covered by these Specifications and indicated on the Drawings. The excavation shall include, without classification, the removal and disposal of all materials of whatever nature encountered, including water and all other obstructions that would interfere with the proper construction and completion of the required work.

1.02 RELATED SECTIONS

A. Section 02 41 00 - Demolition.

B. Section 31 23 19 - Dewatering.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. Washington State Department of Transportation (WSDOT), *Standard Specifications for Road, Bridge and Municipal Construction* (Standard Specifications), 2018.

1.04 SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Submittal Procedures.

B. Submit the following:

1. Shoring Plan, designed and stamped by a Professional Engineer licensed in Washington State. Shoring plan shall acknowledge shoring recommendations provided in the geotechnical report available for review per Section 00 31 00 Available Project Information. If these recommendations are not followed, the Shoring Plan shall explain why.

2. Samples and Test Results:

a. Furnish, without additional cost to the Owner, such quantities of import materials as may be required by the Engineer for test purposes. Cooperate with the Engineer and furnish necessary facilities for sampling and testing of all materials and workmanship.

b. Submit supplier name and test results for all import materials required in this Specification, for Engineer’s approval, with sufficient lead time for Engineer to review and approve prior to delivery to site. Tests shall be performed within 6 months of the submission.

c. Tests shall be completed by a qualified testing laboratory or agency. Accompanying documentation should indicate that test results comply with these Specifications.

d. All material furnished, and all work performed, shall be subject to rigid inspection. No material shall be delivered to the site until it has been favorably reviewed by the Engineer, or used in the construction work until it has been inspected in the field by the Engineer.

1.05 QUALITY ASSURANCE

A. Source Quality Control: Test import materials proposed for use to demonstrate that the materials conform to the specified requirements. Tests shall be performed by an independent testing laboratory employed by the Contractor.

B. FIELD QUALITY CONTROL

1. The Engineer will:
    a. Observe placement and compaction of fill.
    b. Soil testing during placement of fill will be provided by the Owner. Testing will be performed to verify conformance with material requirements defined herein. Tests shall be performed prior to delivery to the site.
    c. Review results of independent testing laboratory tests.
2. Contractor shall:
    a. Be responsible for costs of additional inspection and re-testing resulting from non-compliance.
    b. Provide testing results to the Engineer.

C. TESTING METHODS
1. Field testing procedures shall be a WSDOT, AASHTO or ASTM test procedure as specified.
2. Chemical analytical testing shall conform to the requirements of Part 3.16 of this section.

D. DEFINITIONS
1. Relative Compaction: In-place dry density divided by the maximum dry density laboratory compaction expressed as percentage.

1.06 SUBSURFACE INVESTIGATIONS

A. Geotechnical investigations for design purposes for this project are available for review per Section 00 31 00 Available Project Information.

1.07 ADDITIONAL SAFETY RESPONSIBILITIES

A. The Contractor shall select, install and maintain shoring, sheeting, bracing, and sloping as necessary to maintain safe excavations. The Contractor shall be responsible for ensuring such measures: (1) comply fully with WAC 296-155-650 through 66411, Part N - Excavation, Trenching, and Shoring, (2) provide necessary support to the sides of excavations, (3) provide safe access to the Engineer's sampling and testing within the excavation, (4) provide safe access for backfill, compaction, and compaction testings, and (5) otherwise maintain excavations in a safe manner that shall not endanger property, life, health, or the project schedule. All earthwork shall be performed in strict accordance with applicable law, including local ordinances, and applicable DOSH (Washington Department of Labor and Industries Division of Occupational Safety and Heath) requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Import materials shall be natural, virgin materials, meeting the chemical standards identified in Part 3.16.F and other specifications herein.

B. Native materials will not be suitable for backfill and should be removed from the site.

C. Aggregates: Contractor shall not use crushed concrete as aggregate.
1. Overexcavation Support:
    a. Gravel Borrow: WSDOT Standard Specification 9-03.14(1).
2. Backfill Around Completed Structures:

a. Gravel Borrow for Structural Earth Walls: WSDOT Standard Specification 9-03.14(4).

3. Trench Backfill:

a. Bank Run Gravel for Trench Backfill: WSDOT Standard Specification 9-03.19.

4. Foundation Granular Base Course:

a. Crushed Surfacing Base Course: WSDOT Standard Specification 9-03.9(3).

5. Pipe Bedding:

a. Gravel Backfill for Pipe Zone Bedding: WSDOT Standard Specification 9-03.12(3).

6. Structural Backfill:

a. Gravel Borrow: WSDOT Standard Specification 9-03.14(1).

7. Excavation Bottom Stabilization:

a. 6-inch to 3/4-inch crushed rock with less than 10 percent passing the No. 200 sieve or Quarry Spalls, to be determined by the Engineer.

D. Imported Water for Flushing: Water quality must be approved by the Engineer.

E. Crushed Surfacing Top Course, WSDOT Standard Specifications 9-03.9(3).

F. Crushed Surfacing Base Course, WSDOT Standard Specifications 9-03.9(3).

G. Warning Tape: 6-inch-wide, minimum 4-mil thick, inert, fade-resistant plastic film resistant to acids, alkalis, and other components likely to be encountered in soil. Tape shall be green, imprinted with “CAUTION STORM DRAIN BELOW,” Griffolyn Terra Tape; Seton; or approved equal.

PART 3 - EXECUTION

3.01 EXISTING UTILITIES

A. General: The known existing buried utilities and pipelines are shown on the Drawings in their approximate location. The Contractor shall exercise care in avoiding damage to all utilities as the Contractor will be held responsible for their repair if damaged. There is no guarantee that all utilities or obstructions are shown, or that locations indicated are accurate. Utilities are piping, conduits, wire, cable, ducts, manholes, pull boxes and the like, located at the project site.

B. Check on Locations (Potholing): Hire a private utility company and coordinate with public utilities to locate the respective utilities prior to the start of “potholing” procedures.

C. Clearly paint the location of all affected utility underground pipes, conduits and other utilities on the pavement or identify the location with suitable markers if not on pavement. In addition to the location of metallic pipes and conduits, non-metallic pipe, ducts and conduits shall also be similarly located using surface indicators and shall then be similarly marked.

D. After the utility survey is completed, verify the actual location and elevation of all utilities where crossings, interferences, or connections to new pipelines or other facilities are shown on the Drawings, marked by the utility companies, or indicated by surface signs.

E. Excavations around underground electrical ducts and conduits shall be performed using extreme caution to prevent injury to workmen or damage to electrical ducts or conduits. Similar precautions shall be exercised around gas lines, telephone and television cables. Backfill after completing potholing.

F. Interferences: If interferences occur at locations other than shown on the Drawings, the Contractor shall notify the Engineer, and a method for correcting said interferences shall be supplied by the Engineer. If the Contractor does not verify all required utilities prior to shop drawing preparation, the Contractor shall not be entitled to additional compensation for work necessary to avoid interferences, nor for repair to damaged utilities and any associated collateral damage.

G. Any necessary relocations of utilities, whether shown on the Drawings or not, shall be coordinated with the affected utility. The Contractor shall perform the relocation only if instructed to do so in writing from the utility and the Engineer.

H. Shutdowns: Planned utility service shutdowns shall be accomplished during period of minimum use. In some cases this may require night or weekend work. Such work shall be at no additional cost to the Owner. Program work so that service will be restored in the minimum possible time, and cooperate with the utility companies in reducing shutdowns of utility systems to a minimum.

1. Disconnections: No utility shall be disconnected without prior written approval from the utility owner. When it is necessary to disconnect a utility, the Contractor shall give the utility owner not less than 72 hours of notice when requesting written approval. The Contractor shall program work so that service will be restored in the minimum possible time.

I. Overhead Facilities: Overhead utilities may not be shown on the Drawings. Extreme caution shall be used when working in the vicinity of overhead utilities so as to prevent injury to workmen or damage to the utilities. The Contractor shall be required to comply with the applicable provisions of the WAC 296-24-960 when working anywhere on this project.

3.02 OBSTRUCTIONS

A. Rip rap was not encountered in the soil borings drilled for this project, however it may be present within the work area. The Contractor shall use appropriate equipment and shoring if rip rap is encountered.

3.03 GENERAL CONSTRUCTION REQUIREMENTS

A. Barriers: Barriers shall be placed at each end of excavations at such places along excavations as may be necessary to warn all pedestrian and vehicular traffic of such excavations.

B. Demolition of Pavement: Where trenching or excavation occurs in paved areas, the pavement shall be sawcut and broken ahead of the trenching or excavation operation. The extent of paving removed shall be limited to the minimum necessary for the excavation.

C. Dust Control: Take proper and efficient steps to control dust.

D. Permits: Refer to General Conditions.

E. Storage of Materials: Neatly place excavated materials far enough from the excavation to prevent stability problems. Place materials on and under plastic sheeting. Keep the materials shaped so as to cause the least possible interference with facility operations and drainage.

F. Existing Facilities: Maintain access to existing facilities to permit continued operation. Maintain access for fire-fighting equipment and to fire hydrants.

3.04 COMPACTION

A. Add water to the backfill material or dry the material as necessary to obtain moisture content within 2 percent of optimum as determined by laboratory testing results. Employ such means as may be necessary to secure a uniform moisture content throughout the material of each layer being compacted.

B. After the material has been moisture conditioned, compact it with compaction equipment appropriate for the use to achieve specified compaction. Maximum 12-inch lifts are recommended for hand tamping and maximum 2-foot lifts are recommended for track-hoe plate compactors. Hoe-mounted compactors may only be used within 5 feet of concrete embedded walls or structures at 28-day strength.

C. If the backfill material becomes saturated from rains or any other source because it was not compacted to the specified density or was not backfilled and compacted to surface grade, through negligence or otherwise, remove the faulty material and replace it with suitable material compacted to the specified density. No additional payment will be made for doing such work or removal and replacement.

D. Compaction of backfill materials by flooding, ponding or jetting is not permitted.

E. When densities of compacted materials do not meet the requirements, remove and/or recompact the material until the requirements are met. If the Engineer determines that the nature of the ground in which the excavation lies precludes compaction of the backfill to the specified density, compact the backfill to the maximum practicable density.

F. MATERIAL REQUIREMENTS

1. Backfill Around Completed Structures: Compact to a minimum 95 percent of maximum density, in accordance with ASTM D 1557 for the upper 2 feet. Compact to a minimum 92 percent of maximum density below a depth of 2 feet. A small hand compactor such as a jumping jack should be used near the walls.

2. Foundation Granular Base Course: Compact to a minimum 92 percent of maximum density, in accordance with ASTM D 1557.

3. Trench Backfill: Compact to a minimum 95 percent of maximum density, in accordance with ASTM D 1557 for the upper 2 feet. Compact to a minimum 92 percent maximum density below 2 feet below grade.

4. Pipe Zone Material: Compact by hand methods under the haunches of the pipe and in areas not accessible to mechanical tampers unless otherwise specified or shown on the Drawings.

G. Testing Frequency (as a minimum, to be determined by the Engineer):

1. Trench Backfill: Test every 50 feet of trench or a minimum of 1 test per trench.

2. Earthwork: Test every 500 square feet for each 2 feet of fill.

3. Structural Backfill: Test every 200 square feet

3.05 TRENCH EXCAVATION

A. Excavation for pipe and other utilities shall be supported with shoring. The trench shall be as wide as necessary for sheeting and bracing and the proper performance of the work up to the maximum width permitted by the typical cross-sections shown on the Drawings. The sides of the trenches shall be vertical. The bottom of the trench shall be constructed to the grades and shapes indicated on the Drawings. Should the Contractor desire to use other equivalent methods, the method of construction shall be submitted to the Engineer for approval prior to its use.

B. Take care not to overexcavate. Accurately grade the bottom of the trenches to provide uniform bearing and support for each section of the pipe or conduit at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Dig bell holes and depressions

for joints after the trench bottom has been graded. In order that the pipe rest on the bedding for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth and width as required for properly making the joint. Remove stones as necessary to avoid point bearing. If unstable soil conditions are encountered at the bottom of the excavation, notify the Engineer. It may be necessary to overexcavate and install bottom stabilization material, at the Engineer's discretion.

C. Backfill and compact overexcavations in accordance with the requirements of Part 3.04 with bedding material. There shall be no additional payment to the Contractor for over-excavations not directed by the Engineer. Remove unsatisfactory material encountered below the grades shown as directed by the Engineer and replace with overexcavation support material.

D. Grade trenches so that they are uniformly sloped between the pipe elevations shown on the Drawings. Provide a minimum of 3 feet of cover over pipes. Comply with the minimum and maximum trench widths shown on the Drawings. Notify the Engineer if the trench width exceeds the maximum allowable width for any reason.

E. Open trenches across active terminal traffic routes shall be covered with steel plates, minimum 1-inch thick. Plates shall be pinned against displacement, with edges feathered with cold-mix AC for smooth transitions.

F. Provide ladders for access to the trench by construction and inspection personnel.

3.06 EXCAVATION FOR STRUCTURES

A. Excavation for structures shall be supported with shoring. All excavation for structures shall be done to the dimensions and levels indicated on the Drawings or specified herein. Excavate to such width outside the lines of the structure to be constructed as may be required for proper working methods, the erection of forms and the protection of the work.

B. Take care to preserve the foundation surfaces in an undisturbed condition. If the Contractor over excavates or disturbs the foundation surfaces without written authorization of the Engineer, the Contractor shall replace such foundations with structural fill or other material approved by the Engineer in a manner that will show by test an equal bearing value with the undisturbed foundation material. No additional payment will be made for the added quantity of concrete fill or other material used because of over excavation.

C. Inspection of Excavation: Notify the Engineer when excavation for the structure is complete. No forms, reinforcing steel, concrete, or precast structure shall be placed until the excavation has been inspected by the Engineer.

D. Where unsatisfactory material is encountered below the grades shown for structural excavations, it shall be removed and replaced as directed by the Engineer and compacted.

3.07 SUPPORT OF EXCAVATIONS

A. Adequately support excavations for trenches and structures to meet all applicable requirements in the current rules, orders and regulations. Excavation shall be adequately shored, braced and sheeted so that the earth will not slide or settle and so that all existing structures and all new pipe and structures will be fully protected from damage. Keep vehicles, equipment, and materials far enough from the excavation to prevent instability.

B. Take all necessary measures to protect excavations and adjacent improvements from running, caving, boiling, settling, or sliding soil resulting from the high groundwater table and the nature of the soil excavated.

C. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting and bracing

shall be carefully removed so that there shall be no voids created and no caving, lateral movement or flowing of the subsoils.

3.08 TRENCH BACKFILL

A. Place bedding and backfill materials true to the lines, grades, and cross-sections indicated on the Drawings and compacted to the degree specified on the Drawings. Place bedding and backfill materials in horizontal lifts not to exceed 6 inches in thickness measured before compaction. The difference in level on either side of a pipe shall not exceed 4 inches.

B. Backfill material shall not be placed over the pipe or conduit until after the joints have been completed and inspected by the Engineer.

C. It shall be incumbent upon the Contractor to protect the pipe or conduit from damage during the construction period. It shall be the Contractor's responsibility to repair broken or damaged pipe at no extra cost to the Owner. Carefully place backfill around and over the pipe. Tamping of backfill over the pipe shall be done with tampers, vibratory rollers and other machines that will not injure or disturb the pipe.

D. Do not allow construction traffic nor facility traffic over the pipe trench until the trench backfill has been brought back even with existing adjacent grade.

3.09 TEMPORARY TRENCH COVER

A. To maintain vehicular traffic at and around trench work, provide temporary steel plate trench covers of thickness to support 125,000-lb wheel loads distributed to 300 psi as present at the site based on span dimension across trenches.

B. Remove temporary trench covers as soon as underground utility work is completed to allow backfill and compaction work.

3.10 STRUCTURAL BACKFILL

A. Foundation Granular Base Course: Place a layer of aggregate base, compacted in accordance with the requirements of Part 3.04, under structures to the lines, grades and minimum thicknesses shown on the Drawings.

B. Backfill Adjacent to Structures:

1. Backfill shall be per Part 2.01B compacted in accordance with the requirements of Part 3.04.

2. Do not place backfill against structures until the concrete has been patched and cured.

3. Do not place backfill against hydraulic structures until the structure has passed the specified leakage tests.

4. Place backfill in uniform, level layers.

3.11 PAVEMENT SUBGRADE PREPARATION

A. Preparation of Subgrade: Immediately prior to placement of surfacing materials, clean the entire width of the area of all debris and dispose of as directed by the Engineer. All depressions or ruts which contain storm water shall be drained.

1. Shape the entire subgrade to a smooth uniform surface.

2. Compact the subgrade material for a depth of 6 inches below the subgrade to 95 percent of the maximum dry density as determined by compaction test ASTM D 698.

3. If soft or spongy material underlying the upper six inches of the area being prepared precludes satisfactory compaction of the upper six inches, loosen, aerate, or excavate, replace and compact to the required density as directed by the Engineer.

4. Remove and dispose of excess material which cannot be disposed of by normal drifting to low spots during blading and shaping operations or by placing in subgrade areas deficient in materials or by wasting, all as directed by the Engineer.

5. Bring subgrade areas deficient in materials to grade by importing suitable materials from other subgrade areas or other sources as directed by the Engineer.

6. Water materials added to subgrade areas deficient in materials and compact as necessary to yield a true finished subgrade as described above.

7. Once it is prepared, maintain the subgrade for surfacing in the finished condition until the first course of surfacing has been placed.

B. Finishing Subgrades: Before any paving material is placed, bring the subgrade to the proper line, grade and cross section and maintain until the base course and paving is placed.

1. Compact the subgrade for pavement to 95 percent of maximum dry density as defined for Compaction Control Density, Article “Compaction Control Tests” in these Specifications, to a minimum depth of 6 inches and to a width that will accommodate the paving equipment.

C. Subgrade Protection: Take all precautions necessary to protect the subgrade from damage; hauling over the finished subgrade shall be limited to that which is essential for construction purposes.

1. Equipment used for hauling over the prepared subgrade which, in the opinion of the Engineer, is causing undue damage to the prepared subgrade or to the underlying materials, shall be removed from the work at the request of the Engineer.

2. Repair at the Contractor’s expense all cuts, ruts and breaks in the surface of the subgrade prior to placing surfacing, treated base, or paving materials.

3. Protect the prepared subgrade from both the Contractor’s traffic and public traffic and maintain the subgrade by blading and rolling as frequently as may be necessary to preserve the subgrade in a completely satisfactory condition.

3.12 AUTHORIZED OVEREXCAVATION AND BACKFILL

A. The Contractor shall not excavate or backfill beyond the lines and grades shown in the Contract Documents unless authorized by the Engineer. Unauthorized overexcavation and backfill shall be at the Contractor’s expense.

B. Overexcavation and backfill that is required to repair deteriorated grades, as a result of the Contractor’s operations will not be considered authorized overexcavation and backfill work.

C. Authorized overexcavation and backfill may be directed by the Engineer for trench foundation grade conditions.

D. The Engineer will direct the Contractor to excavate beyond the lines and grades shown on the Contract Documents and to backfill the authorized overexcavation with Gravel Borrow or Excavation Stabilization Material, depending on subsurface conditions. Overexcavation and backfill may be required in the following cases:

1. Unsuitable soil materials exposed at required trench excavations.

2. Unsatisfactory soils due to excessive moisture in native soils located at required trench excavations, or seepage in native soils.

E. Authorized overexcavation and backfill quantities shall be quantified as tons. The Contractor shall backfill the overexcavation with specified materials. Refer to Section 01 20 00 for price and payment procedure.

F. The Contractor shall record all authorized overexcavation and backfill locations on the Record Drawings.

3.13 FINISH GRADING

A. Except where shown otherwise in the Drawings, restore the finish grade to the original contours and to the original drainage patterns. Grade surfaces to drain away from structures. The finished surfaces shall be smooth and compacted.

3.14 REGULATED MATERIALS IN SOIL

A. Contractor shall monitor soils and groundwater by instructing workers in observing and reporting suspicious materials. Indicators of suspicious materials include but are not limited to refuse, odors, oily sheen or color on soils and water, and oily or chemical odors. If unexpected suspicious materials are encountered, Contractor shall stop work in that area immediately and notify the Engineer.

3.15 EXCAVATED MATERIAL CHARACTERIZATION AND DISPOSAL

A. Excess excavated material to be exported from the site must be stockpiled and characterized prior to off-site disposal. The Contractor will stockpile material at a location on site as directed by the Engineer. Stockpiled material shall be placed onto plastic sheeting, covered and anchored to prevent rain water from contacting material. Contractor shall base their bid on the assumption that excavated material is not regulated.

B. Segregate and stockpile material for Owner examination, identification, characterization, and testing.

1. Notify the Engineer when materials are ready for testing.

2. Contractor will allow 21 days for characterization of stockpiled materials.

3. Owner will pay for and conduct testing of excavated materials to be hauled off site, to determine whether the material is regulated or non-regulated for disposal purposes. Additional testing beyond determination of whether the material is regulated or non-regulated is the responsibility of the Contractor.

4. Owner will be responsible for identifying whether material is regulated or non-regulated solid waste under this Contract.

C. Under this Contract, material will be characterized as non-regulated solid waste if Owner testing indicates that concentrations are equal to or below concentrations identified in WAC 173-340-900 Table 740-1 (Method A Soil Cleanup Levels for Unrestricted Land Use) and if material is not designated as dangerous waste per WAC 173-303. The Owner may base its identification of regulated or non-regulated material on one, several, or all of the parameters listed in WAC 173-340-900 Table 740-1 and WAC 173-303 (Dangerous Waste Regulations), at its own discretion.

1. Further management, handling, and disposal of material identified by the Owner to be non-regulated shall be the responsibility of the Contractor. The Contractor shall be responsible for the performance and cost of any additional characterization and testing of non-regulated material that may be required for Contractor’s choice of disposal locations.

2. Further management of regulated material through loading, transport and disposal of the material will be the responsibility of the Contractor.

3. Regulated material: Quantity shall be quantified as tons. Refer to Section 01 20 00 for price and payment procedure.

D. Clean excess soils generated during site activities may be used for backfill and other fills associated with the work, as approved by the Engineer.

3.16 IMPORT MATERIAL CHARACTERIZATION TESTING, REPORTING, AND CERTIFICATION

A. Provide characterization and testing as described below for import materials.

B. The Contractor is responsible for all testing costs associated with characterization of import materials. The chemical testing laboratory shall be certified under WAC Chapter 173-50.

C. A minimum of three samples are required for each import material source of volumes of 5,000 cubic yards or less. One additional sample is required for every additional increment of 10,000 cubic yards or less from the same source.

D. Provide the following information with each sample result submitted to the Engineer for approval:

1. Material source
2. Material type per designations in Part 2.01, planned import volume, and proposed on-site use
3. Sampling dates
4. Chain of custody
5. Sampling locations on a map area with sufficient detail to allow the Owner to re-test of necessary
6. Contractor’s certification that the sample results submitted are representative of the materials that shall be imported at the site and meet the standards identified in Part 3.16F of this section.

E. Characterization Testing shall include:

1. Grain Size Distribution (ASTM D 4 22).
2. Maximum Dry Density (ASTM D 698).
3. Weight per unit volume of uncompacted material (ASTM C 29).
4. Priority Pollutant Metals (EPA SW 846 6010/6020/ 7041).
5. Volatile Organic Compounds (EPA SW 846 8260).
6. Semi-volatile Organic Compounds (EPA SW 846 8270).
7. PCBs and Pesticides (EPA SW 846 8080).
8. Petroleum Hydrocarbons (NWTPH-HCID).

F. EPA methods are available through SW-846 online:

1. http://www.epa.gov/osw/hazard/testmethods/sw846/online/index.htm.

G. NWTPH methods are available online through http://www.ecy.wa.gov/biblio/97602.html.

H. Chemical Standards for Import Material: The chemical criteria identified in WAC 173-340-900 Table 740-1 (Method A Cleanup Levels for Unrestricted Land Use).

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Furnishing all labor, material, equipment, tools, and services required for the placing and compacting of asphalt concrete pavement at the site to the lines, grades, and dimensions shown on the Drawings and as specified herein.

1. Also included shall be the repair and resurfacing of existing paving damaged or removed during construction.

1.02 REFERENCE SPECIFICATIONS

A. American Society for Testing and Materials (ASTM) Standard Specifications:

1. ASTM D 422: Test Method for Particle-Size Analysis for Soils
2. ASTM D 1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
3. ASTM D 2027: Specification for Cutback Asphalt (Medium Curing Type)
4. ASTM D 2922: Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

B. WSDOT:

1. All field and Laboratory materials testing by the Owner will follow methods described in Contract documents, or in the WSDOT Materials Manual M 46-01, using qualified testing personnel and calibrated or verified equipment.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Submittal Procedures.

B. Submit the following:

1. Samples: Furnish, without additional cost to the Owner, such quantities of construction materials as may be required by the Engineer for test purposes. The Contractor shall cooperate with the Engineer and furnish necessary facilities for sampling and testing of all materials and workmanship. All materials furnished and all work performed shall be subject to rigid inspection, and no materials shall be used in the construction work until it has been inspected by the Engineer.
2. Submit a signed verification from each source of supply for each construction material employed on this project indicating that the materials meet the Specification requirements.
3. Mix design for asphalt concrete. An approved mix design, listed on the WSDOT Qualified Products List (QPL) is required for all HMA paving.
4. Submit manufacturer’s certification of the actual volatile organic compound (VOC) content for all pavement paints and bituminous pavement sealers proposed for use on this project. Submit certification of the actual VOC content for coatings manufactured after 1 September 1987. For coatings manufactured before 1 September 1987, submit VOC content and date of manufacture. VOC content shall be measured in grams per liter by weight of coating as applied excluding water and color added to the tint base.
5. Submit verification to local air pollution authorities and the State Department of Ecology that bituminous pavement sealers and paint products furnished meet applicable

regulations as to allowable VOC content for the time and place of application and use intended.

6. Submit smoothness measurements and surface grade survey results to the Engineer prior to application for payment.

1.04 QUALITY ASSURANCE

A. All pavement stripe painting shall be performed by competent and experienced Equipment operators and painters using proper equipment, tools, stencils, templates, and shields in a workmanlike manner.

1.05 REGULATORY REQUIREMENTS

A. All work, material, procedures and practices under this section shall conform to all rules of local air pollution authorities. If there are none, air-quality rules of the State Department of Ecology shall govern the Work.

PART 2 - PRODUCTS

2.01 APPROVAL OF MATERIALS

A. Acceptance of materials shall be in accordance with section 1-06 of the WSDOT Standard Specifications.

2.02 ASPHALT CONCRETE

A. Asphalt Concrete shall be HMA CL.1/2-inch PG 64-22 mix and conform to the applicable requirements of Sections 5-04, 9-02, and 9-03 of the WSDOT Standard Specifications. Reference to Division 1 of the WSDOT Standard Specifications in these sections shall not apply except as provided for in this section. Commercial HMA is not acceptable. Mineral filler and proportioning shall be as set forth in 2.02.

B. Only Performance Graded Asphalt Binder (PGAB 64-22) conforming to the requirements of Section 9-02.1 of the WSDOT Standard Specifications shall be used as the asphalt binder.

C. The WSDOT Asphalt Supplier of Performance Graded Asphalt Binder (PGAB) shall have a Quality Control Plan (QCP) in accordance with WSDOT QC 2 “Standard Practice for Asphalt Suppliers That Certify Performance Graded and Emulsified Asphalts.” The Asphalt Supplier’s QCP shall be submitted and approved by the WSDOT State Materials Laboratory.

2.03 AGGREGATES FOR ASPHALT CONCRETE

A. GENERAL REQUIREMENTS

1. Aggregates for asphalt concrete shall be manufactured from ledge rock, talus, or gravel. The material from which they are produced shall meet the following requirements:

   a. Los Angeles Wear, 500 Rev. 30% max.

   b. Degradation Factor, Wearing Course 30 min.

   c. Degradation Factor, Other Courses 20 min.

2. It shall be uniform quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of any size between consecutive laboratory sieves.

3. Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that

the oven-dried material retained on a 1/4-inch square sieve shall not contain more than 0.1 percent by weight of material with a specific gravity less than 1.0.

B. TEST REQUIREMENTS

1. Aggregate for asphalt concrete shall meet the following test requirements:

a. Minimum 45 percent sand equivalent.

b. The fracture requirements are at least one fractured face on 90 percent of the material retained on each specification sieve size No. 4 and above, if that sieve retains more than 5 percent of the total sample.

c. When material is being produced and stockpiled for use on a specific contract or for a future contract, the fracture and sand equivalent requirements shall apply at the time of stockpiling. When material is used from a stockpile that has not been tested as provided above, the requirements for fracture and sand equivalents shall apply at the time of its introduction to the cold feed of the mixing plant. The properties of the aggregate in a preliminary mix design for asphalt concrete shall be such that, when it is combined within the limits set forth in Part 2.02 F. and mixed in the laboratory with the designated grade of asphalt, mixtures with the following test values can be produced:

2. Asphalt Concrete:

a. Percent Air Voids 2-5.5

C. GRADING

1. Gradation:

a. The Contractor may furnish aggregates for use on the same contract from a single stockpile or from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Part 2.02 F. Acceptance of the aggregate gradation shall be based on samples taken from the final mix.

2. Gradation - Recycled Asphalt Pavement and Mineral Aggregate:

a. Asphalt concrete planings or old asphalt concrete utilized in the production of asphalt concrete shall be sized prior to entering the mixer so that a uniform and thoroughly mixed asphalt concrete is produced in the mixer. If there is evidence of the old asphalt concrete not breaking down during the heating and mixing of the asphalt concrete, the Engineer may elect to modify the maximum size entering the mixer. No contamination by deleterious materials will be allowed in the old asphalt concrete used.

b. The gradation for the new aggregate used in the production of the asphalt concrete shall be the responsibility of the Contractor, and when combined with recycled material the combined material shall meet the gradation specification requirements for the specified Class ACP as listed in Parts 2.02 F. and 2.02 G. The new aggregate shall meet the general requirements listed in Part 2.02 A. and shall meet the appropriate fracture and sand equivalent requirements as listed in Part 2.02 B.

D. BLENDING SAND

1. In the production of aggregate for asphalt concrete, there is often a deficiency of material passing the U.S. No. 40. When this occurs, blending sand in an amount specified by the Engineer may be used to make up this deficiency, provided that a satisfactory final mix is produced, including fracture requirements.

2. Blending sand shall be clean, hard, sound material, either naturally occurring sand or crusher fines, and must be material which will readily accept an asphalt coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Part 2.02 F. for the class of material involved. Blending sand shall meet the following quality requirement:

    a. Sand Equivalent 27 min.

E. MINERAL FILLER

1. Mineral filler, when used in ACP mix, shall conform to the requirements of AASHTO M17.

F. PROPORTIONS OF MATERIALS

1. The materials of which asphalt concrete is composed shall be of such sizes, gradings, and quantities that, when proportioned and mixed together, the materials will produce a well graded mixture within the requirements listed in the following table.

SIEVE SIZE	PERCENT PASSING
3/4"	99-100
1/2"	90-100
3/8"	90 Maximum
No. 8	28-58
No. 40	11-24
No. 200	2.0-7.0

2. The percentages of aggregate refer to completed dry mix, and includes mineral filler when used.

G. BASIS OF ACCEPTANCE

1. Asphalt concrete will be accepted based on its conformance to the approved mix design, which will be considered the project job mix formula (JMF).

2. Asphalt concrete mixture shall be evaluated for acceptance using statistical evaluation in accordance with WSDOT Standard Specifications Section 5-04.3(9)B.

3. Job Mix Formula Tolerances and Adjustments:

    a. Tolerances - Statistical Acceptance. After the JMF is determined, the several constituents of the mixture at the time of acceptance shall conform to the following tolerances:

CONSTITUENT OF MIXTURE	**TOLERANCE LIMITS**
	THE TOLERANCE LIMIT FOR EACH MIX CONSTITUENT SHALL NOT EXCEED THE BROAD BAND SPECIFICATION LIMITS SPECIFIED IN PART 2.02 F, EXCEPT THE TOLERANCE LIMITS FOR SIEVES DESIGNATED AS 100% PASSING WILL BE 99-100.
AGGREGATE PASSING 3/4", 1/2", 3/8" SIEVE	± 6%
AGGREGATE PASSING NO. 8 SIEVE	± 4%

AGGREGATE PASSING NO. 200 SIEVE	± 2.0%
ASPHALT BINDER	± 0.5%

A. Adjustments:

1. Aggregates. Upon written request from the Contractor, the Project Engineer may approve field adjustments to the JMF including the Contractor's proposed combining ratios for mineral aggregate stockpiles, blend sand, and RAP. The maximum allowed gradation change shall be 2 percent for the aggregate retained on the No. 4 sieve and above, 1 percent for the aggregate passing the No. 8 sieve, and 0.5 percent for the aggregate passing the No. 200 sieve. Blend sand may be changed a maximum of 5 percent. The above adjustments and/or any further adjustments as ordered by the Engineer will be considered as a new JMF. Adjustments beyond these limits will require development of a new JMF. The adjusted JMF plus or minus the allowed tolerances shall be within the range of the broad band specifications.

    a. Asphalt Content. The Project Engineer may order or approve the Contractor's request to change asphalt content a maximum of 0.3 percent from the approved JMF.

2.04 TACK COAT

A. Unless otherwise approved by the Engineer, the tack coat shall be CSS-1, CSS-1h, or STE-1 emulsified asphalt. The CSS-1 and CSS-1h emulsified asphalt may be diluted with water at a rate not to exceed one part water to one part emulsified asphalt. The tack coat shall not exceed the maximum temperature recommended by the emulsified asphalt manufacturer. Refer to Section 5-04.3(4) of the WSDOT Standard Specifications for all applicable requirements.

2.05 PRIME COAT (PENETRATION TREATMENT)

A. Material for prime coat shall be liquid asphalt conforming to the requirements of Section 5-02.2 of the WSDOT Standard Specifications and ASTM D 2027.

2.06 STRIPES

A. Striping paint shall be non-reflective Sherwin Williams Series 338-116(W), 338-117(Y) and 338-333(B); Pervo Paint Company No. 4773-A(W), 4473-4A(Y), and 473-5A(B); or approved equal. Paint shall be stored at the project site in the manufacturer's sealed and labeled containers. Labels shall clearly identify the manufacturer, specification number, batch number, intended use, quantity and contract number.

2.07 TEMPORARY PAVEMENT (COLD MIX)

A. Temporary pavement shall consist of No. 4 sieve maximum aggregate size, graded in accordance with Section 9-03 of the WSDOT Standard Specifications. The aggregate shall be blended with 5-8 percent liquid asphalt that conforms to ASTM D 2026.

PART 3 - EXECUTION

3.01 GENERAL

A. This Specification shall cover newly paved areas as well as existing pavement restoration.

B. Where trenching or other construction activity has resulted in damage to a localized area of pavement, the damaged pavement shall be cut back 6 inches and shall be removed and replaced.

C. Where the damaged area extends over more than 50% of the paved area, as determined by the Engineer, the full pavement width or area shall be cut away, removed and repaired.

D. Structures such as valve boxes, manhole frames and covers, and electrical vaults shall be adjusted to grade as necessary within paved areas.

E. Existing asphalt pavement islands of 50 ft² or less and strips 18 inches or less in width shall be removed and replaced.

F. Adjust existing manholes, meter boxes, cleanouts, etc. to match the new grade using approved precast rings. Bricks are not acceptable.

3.02 PAVEMENT CUTTING

A. The asphalt pavement shall be saw cut (using a concrete saw) to full depth. The pavement shall be cut back 6 inches on each side of the trench or excavation wall. Any pavement damaged outside these lines shall be re-cut and restored at the expense of the Contractor. Should voids develop under existing pavements during construction, those affected pavements shall be neatly saw cut in straight lines and replaced after the voids have been filled.

B. Construct joints between successive runs vertical and at right angles to the line of the improvement. Exercise care in construction of all joints to ensure that the surface of the pavement is true to grade and cross-section. Lapped joints will not be permitted.

3.03 PRIME COAT APPLICATION

A. Prime Coat: In advance of spreading paving materials, a prime coat of liquid asphalt shall be applied to all base course surface areas to be covered with asphaltic concrete.

1. Preparation of Base Course: Immediately before applying the prime coat, the area to be surfaced shall be cleaned of all loose material by means of hand brooms.

2. Application: Liquid asphalt shall be applied by pressure distributors at a temperature between 125 and 200°F. The Engineer reserves the right to require an adjustment of the temperature of the liquid asphalt at the time of placement. The rate of application shall be between 2/10 and 3/10 gallon per square yard. Excess liquid asphalt, which has failed to penetrate the base, shall be covered with fine sand. All loose sand shall be removed from the treated areas before placing any surfacing material thereon. Liquid asphalt shall not be applied when the atmospheric temperature is below 50°F. The prime coat shall be applied at least 24 hours in advance of paving. Immediately in advance of paving asphalt concrete surfacing, additional prime coats shall be applied, as directed by the Engineer, to areas where the prime coat has been damaged.

3.04 TACK COAT APPLICATION

A. Tack Coat: In advance of spreading bituminous material upon an existing bituminous or portland cement concrete surface, a tack coat shall be applied to all areas to be surfaced and to all vertical surfaces of existing pavement, curb, walls and construction joints in the surfacing against which additional material is to be placed. When two or more lifts of asphaltic concrete are required, a tack coat shall be applied between each lift.

1. Preparation: Immediately before applying a tack coat, the area to be surfaced shall be cleaned of all loose material.

2. Application: The tack coat shall be applied by means of pressure distributors by pressure hand-spray equipment. The rate of application shall be 1/20 gallon per square yard. Emulsified asphalt shall not be applied when the atmospheric temperature is below 40°F. If emulsified asphalt Type SS-1 is used, it may be diluted with an equal part of water. The

rate of application of the dilution shall be such that the rate of application of undiluted emulsion shall be within the tolerances specified.

3.05 PLACEMENT OF ASPHALT CONCRETE

A. Delivery and Spreading: Bituminous mixtures shall be delivered to the roadbed at temperatures specified in the WSDOT Standard Specifications. Spreading of the mixture shall be in accordance with Section 5-04.3(9) of the WSDOT Standard Specifications. All loads shall be covered with tarpaulin or other material during transportation. Asphalt concrete shall be placed in 3 inch lifts.

B. Compaction: Asphalt concrete shall be compacted in accordance with Section 5-04.3(10)A of the WSDOT Standard Specifications. Compaction by vehicular traffic shall not be permitted. The Engineer reserves the right to require an adjustment of the temperature of the asphalt concrete at the time of placement.

C. Asphalt shall be compacted to a minimum of 91 percent of the theoretical maximum density.

D. Pavement Thickness: Pavement shall match the existing adjoining pavement in thickness, or as indicated on the Drawings, or as specified, whichever is greater.

E. Joining Pavement: The joints between old and new pavements or between successive days' work shall be carefully made in such manner as to ensure a continuous bond between old and new sections of the course. Edges of existing pavement shall be exposed and cleaned and edges cut to straight, vertical surfaces. All joints shall be painted with a uniform coat of tack coat before the fresh mixture is applied.

F. Protection of Pavement: After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cooled and hardened and in no case less than 6 hours.

G. Surface smoothness of completed pavement in conformance with the specific requirements of WSDOT Standard Specification Section 5-04.3(13).

3.06 PAVEMENT RESTORATION

A. Final pavement restoration shall be made as soon as practicable after backfilling. In that period of time between backfilling and final pavement restoration, the trench shall be maintained level with the adjacent pavement and shall be covered with a 1-inch minimum layer of cutback. Prior to placing the final pavement, the temporary pavement shall be removed, the aggregate base excavated to the lines indicated on the Drawings, and the existing pavement edges saw cut as herein specified. The asphalt pavement shall not be placed before the primed aggregate base surface is approved by the Engineer.

3.07 PAVEMENT MARKINGS

A. Preparation: Immediately before applying the paint, the pavement surface shall be thoroughly cleaned of all dust, dirt, scale, curing compound, oil, grease, or other objectionable matter as directed by the Engineer. Solvent material that will damage the pavement shall not be used as a cleaning agent.

B. Tolerances: Marking and striping shall be within 2 inches of the correct alignment. Dimensions of marking and striping shall be within ½-inch.

C. Mixing: Mechanical mixers shall be used to mix paint. Prior to applying, the paint shall be mixed a sufficient length of time to thoroughly mix the pigment and vehicle together, and shall be kept thoroughly agitated during its application.

D. Application: Two coats of marking paint shall be applied only on dry surfaces and only during periods of favorable weather. Painting shall not be performed when the atmospheric

temperature is below 40°F when using solvent-borne paint or below 50°F when using water borne paint; when freshly painted surfaces may become damaged by rain, fog, or condensation; nor when it can be anticipated that the atmospheric temperature will drop below said 40°F or 50°F temperatures during the drying period.

1. Immediately following the preparation of the pavement, the paint shall be applied. The paint shall be applied at the rate of 100 to 110 square feet per gallon of paint. The stripe painting machine shall have a compressor capacity of at least 105 cubic feet per minute and be capable of operating at an air pressure of 125 psi. The paint shall be mechanically agitated while the machine is in operation. The striping machine shall be equipped with a guide post so designed that the machine will hold exactly to the alignment. The propelling vehicle shall be equipped with a guide post so designed that the machine will hold exactly to the alignment. The propelling vehicle shall be equipped with a speedometer or tachometer, and with a suitable device for determining the quantity of paint in the container. The paint container and spray nozzles on the machine shall be thoroughly cleaned before starting each day's work. The stripe shall be of the required width, with clean, true edges and without sharp breaks.
2. Allow 10 days between the application of a bituminous seal coat and the permanent pavement marking. The paint shall not bleed, curl or discolor when applied to bituminous surfaces. If bleeding or discoloring occurs, apply an additional coat of paint.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section covers installation of special purpose precast concrete vaults and wet wells to be provided by the owner.

1.02 ADAPTATION OF PRODUCTS

A. Furnish products readily adaptable for installation and operation in the manner shown on the Drawings.

1.03 SUBMITTALS

A. Shop Drawings showing penetration, equipment, and conduit locations to be provided by the Contractor shall be submitted.

PART 2 - PRODUCTS

2.01 WET WELL AND VALVE VAULT

A. The precast concrete wet well with overflow structures and the precast valve vault will be provided by the Owner.

2.02 GENERAL

A. The Contractor is responsible for providing and installing all electrical conduit into and out of the precast wet well provided by the owner. This includes performance of any concrete cores, installation of conduit and supports, and all necessary accessories and appurtenances. All electrical junction boxes shall be installed as high as possible within the wet well and in an area accessible from the top access hatches.

2.03 INSTALLATION

A. Install vault and accessories in conformance with Drawings, Specifications, and recommendations of precast manufacturer unless otherwise instructed in writing by the Engineer. Vault location and orientation shall conform to the Drawings.

B. The vault joints, pipeline, and conduit penetrations through walls, as shown on the plans, shall be sealed using penetration seals as specified and as shown on the Drawings. No leakage will be allowed into the vault or wet well.

C. Concrete fill for sloping vault and wet well bottoms shall be placed by the Contractor in the field in conformance with the Drawings and Specifications.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes of all labor, tools and materials associated with the installation and start-up of the precast wet wells, valve vaults, valves, pumps, associated piping, connections, pipe supports, flap gates, conduit, control panels, floats, ladders, fasteners, hatches, and appurtenances required in the construction of the three Pump Stations for Basins A, B, and C as indicated in the Drawings.

B. Advance Procurement: The Pump Station components, wet wells, valve vaults, and equipment therein will be provided by the Owner. These components shall be received and installed by the Contractor. The Contractor is responsible for provision and installation of any items not provided by the Owner but required to provide a complete and fully functional system.

C. Related Documents: The provisions and intent of the Contract, including the General Conditions, Supplementary Conditions, and General Requirements, apply to the Work as if specified in this section.

D. Related Work Specified Elsewhere:

1. Section 02 41 00 - Demolition shall involve the removal of items necessary for the excavation and construction of Pump Stations to the elevations and locations indicated in the Drawings.

2. Section 31 23 33 - Earthwork shall involve the temporary shoring to be used for the excavation required to install the Pump Station(s) and appurtenances as indicated in the Drawings.

3. Division 31 - Earthwork shall involve work to establish a firm unyielding base foundation for the Pump Station(s) and backfill as indicated in the Drawings.

4. Section 31 23 19 - Dewatering shall involve lowering the groundwater table below the level of excavation to install the components of the Pump Stations to the elevations and locations indicated in the Drawings.

5. Division 22 - Storm Drainage shall involve the installation of all gravity sewer piping supplying stormwater to the wet well at the elevations and locations indicated in the Drawings and in the Specifications and as confirmed by the Contractor during installation.

6. Division 26 - Electrical shall involve the control panel, conduit, and wires to power and control the Pump Station(s) at the locations indicated in the Drawings.

1.02 QUALITY ASSURANCE

A. Testing and Inspection for Contractor Quality Control: Testing shall be performed for each individual Work Area and will be supported by the Pump Station Supplier. The Contractor shall perform the field inspection and tests described below and based upon the results of these inspections and tests, shall take the action required and submit specified reports.

1. Inspection of components upon delivery for any damage or missing components.

2. Coordination and testing for unit activation as directed by the manufacturer.

a. Complete the recommended start up report as recommended by the pump manufacturer.

3. Contractor shall perform a hydrostatic pressure test for each wet well.

a. The hydrostatic pressure test shall be performed after the wet wells have been installed and the inlet and outlets have been sealed with flexible pipe connection, modular mechanical seals, or non-shrink grout as specified and required.

1.03 REFERENCES

A. All equipment shall be assembled and tested in accordance with the most current applicable standards as defined by:

1. Confined Space Entry Precautions - OSHA (8-hour training).
2. Institute of Electrical and Electronic Engineers (IEEE).
3. National Electrical Manufacturers' Association (NEMA).
4. Anti-Friction Bearing Manufacturers' Association (AFBMA).
5. American National Standards Institute (ANSI).
    a. ANSI A21.10 force main fittings.
    b. ANSI A21.50 C150 force main thickness.
    c. ANSI A21.51 C151 force main ductile iron.
6. National Fire Protection Association (NFPA).
7. National Electrical Code (NEC, NFPA 70).
8. Underwriters' Laboratory (UL).

B. Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge and Municipal Construction and Amendments (current edition).

1.04 SUBMITTALS

A. Test Results: All test results required by this section.

B. Delivery sequence.

C. Startup plan and schedule.

PART 2 - PRODUCTS

2.01 GENERAL

A. All major products listed in this specification will be provided by the Owner. The Contractor shall be responsible for provision of all incidentals required for a complete and fully functional installation but not included within the Advance Procurement Package.

B. The equipment within the wet wells and valve vaults will be installed by the manufacturer to the greatest extent possible, prior to delivery.

PART 3 - EXECUTION

3.01 GENERAL

A. Pump stations and valve vaults will be provided by the Owner, sourced by one supplier, and will each be comprehensive units. The Contractor shall install the provided components in accordance with the manufacturer's written instructions.

B. Prior to beginning installation of a Pump Station or Valve Vaults, Contactor shall review Design Drawings, field conditions, and shop drawings of Pump Stations and Valve Vaults and shall

bring to the attention of the Engineer any conditions or discrepancies that could delay system installation or adversely affect system performance.

3.02 DELIVERY AND ACCEPTANCE

A. Contractor shall coordinate with the Owner and Pump Station and Valve Vault Supplier for delivery of the Pump Station and Valve Vault components, including control panels, inspection, unloading, storage, installation and appurtenances. Pump Station and Valve Vault Supplier will support this process as required for timely delivery and construction of the Pump Station.

B. Acceptance of materials shall be on-site and subject to inspection of the finished product, in addition to quality testing. Acceptance of the installed Pump Stations and Valve Vaults shall be based on inspection by the Manufacturer and Engineer.

3.03 LOADING/UNLOADING DELIVERED ITEMS

A. Contractor shall perform all unloading, crane transport, storage and installation once the component is delivered on-site and handed over to the Contractor.

B. The Contractor shall provide spreader bars, straps, etc. to safely lift the main structures and appurtenances per the Pump Station Supplier’s recommendations.

3.04 ALIGNMENT AND GRADE

A. Lay out the mains for alignment and grade as shown on the Drawings.

3.05 TRENCHING FOR PIPE

A. Excavate trenches to the alignments and depths indicated on the Drawings. See Division 31 - Earthwork.

3.06 BACKFILL AND UTILITIES BEDDING

A. Install backfill and bedding as specified in Section 31 23 33 - Earthwork. Do not backfill trenches until all tests and inspections have been made.

3.07 PIPE RESTRAINT SYSTEM

A. See Section 22 13 16 - Pipe and Fittings.

3.08 INSTALLATION AND ASSEMBLY

A. The Contractor shall set the base for the precast concrete wet wells and valve vaults, risers, top slab(s), and all other concrete wet well components.

B. The Contractor shall finish assembling vertical discharge piping, pump guide rails and make all pipe connections as needed after setting and assembling the wet well.

C. Control panel shall be mounted at locations indicated on the Drawings. The Contractor shall provide all tools, labor, and equipment to install the control panel, electrical conduit, wiring and connections from the control panel to the associated components. The Contractor shall be responsible for coordinating conduit penetrations for conduit and junction boxes that shall be provided by the Contractor with the Supplier and Engineer.

D. The Contractor shall install pump floats, overflow chamber float, and float located within the hydrodynamic separator as indicated in the Drawings using the floats, mounting equipment, and appurtenances provided by the Pump Station Supplier.

E. The Contractor shall provide all conduits to connect the hydrodynamic separator, Pump Station, and control panel for the electrical and controls cables required for system operation.

3.09 HYDROSTATIC TESTING

A. All wet wells shall be hydrostatically tested by the Contractor using the below method. If the Pump Station Supplier or Contractor wish to use an alternate method of leakage testing, the proposed method shall be submitted to the Engineer for review and approval.

1. Fill the wet well with water and wait thirty (30) minutes for initial concrete absorption to take place. After the thirty (30) minute wait period is over, Contractor shall measure leakage over a period of not less than one hour.

2. Allowable Leakage: less than one (1) inch drop in water surface elevation over the duration of the test.

3.10 START UP

A. The Contractor shall support the Pump Station Supplier in activation of the Pump Station(s). The Contractor shall provide a minimum of one (1) week notice to the Owner, Pump Station Supplier, and Engineer. The manufacturer's representative shall perform the following start up tasks which shall be witnessed by the Contractor and the Engineer:

1. Startup, check, and operate the pump system.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head.

3. Water for Testing: Contractor is responsible for provision of all water necessary to allow for full operational testing of the system including pump lead/lag cycling, hydrodynamic separator filling and operational testing, treatment unit flow distribution, discharge into the overflow chamber. Water shall be clean and capable of being directly discharged into the effluent storm drain.

B. Pump Lift Test: Contractor shall assist the manufacturer in demonstrating successful removal of pumps from wet well using the guide rail system. Hoists, cranes, and any other lifting mechanisms needed to demonstrate removal shall be provided by the Contractor.

C. If the pumping system fails to meet the indicated requirements, the Contractor shall be responsible for modifying the pumps and re-testing as indicated above, until all stations satisfy the indicated requirements. The Pump Station Supplier shall support the Contractor.

1. Defective pumps or parts discovered during testing shall be replaced. Parts shall be provided by the manufacturer and installed by the initial installation party (i.e., Pump Station Supplier or Contractor).

D. Certification

1. After each pumping system has satisfied the requirements, the Pump Station Supplier shall certify in writing that it has satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field test, a listing of persons present during the tests and the test date.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. The Work under this section includes furnishing all labor, equipment, materials, and appurtenances required for a complete installation of the stormwater treatment systems as shown on the Drawings and specified herein. The stormwater treatment systems will be supplied by the Owner and procurement of these systems is not included in this Contract. Items to be supplied by the Owner are shown on the Drawings. All other items necessary to complete the Work shall be supplied by the Contractor.

B. Related Sections:

C. Section 31 23 33 - Earthwork.

D. Section 31 23 19 - Dewatering.

1.02 REFERENCES

A. Not Used.

1.03 SUBMITTALS

A. Not Used.

1.04 DELIVERY, STORAGE AND HANDLING

A. The Owner's treatment systems supplier shall deliver all treatment system equipment and materials to the West Sitcum Marine Terminal for storage by the Contractor. The specific delivery location shall be designated by the Engineer. Engineer shall coordinate delivery with the Contractor, who shall provide equipment for material offloading at the delivery site.

B. Protect all materials from damage during delivery, offloading, and storage. Cover UV sensitive materials if materials will be stored for more than one week. Storage surfaces should be free from dirt, mud and debris.

C. Filter media shall be stored away and covered to prevent from being fouled by other granular materials and construction related sediment in the air.

PART 2 - PRODUCTS

2.01 TREATMENT SYSTEMS

A. Not Used.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. System components shall be installed at the locations and elevations specified on the Drawings, and in accordance with manufacturer's installation recommendations.

2. The treatment system shall be provided as a package system with all internal piping and structural components included. The Engineer shall inspect the system and give approval prior to installation.

3. The Contractor shall coordinate with the treatment systems supplier, who shall provide a manufacturer's representative for system delivery and start-up. The duration of site visits and support shall be determined by the treatment system manufacturer.

4. Care shall be taken to protect all flexible components of the system during storage, transportation, and installation.
5. The manufacturer’s representative shall provide the Contractor with installation advice and shall provide the Engineer with a written assertion that the treatment units were installed in accordance with the manufacturer’s instructions.
6. All system components, equipment, and materials stored on site shall be covered prior to installation to protect from moisture and contamination.
7. The Contractor shall be responsible for selecting the appropriate equipment to safely rig, lift, unload, and place the system.
8. The system shall not be placed on frozen or excessively wet ground. The Engineer shall have final authority to determine if frozen or excessively wet conditions exist.
9. Grading or placement of aggregates or system components shall not begin until the area draining to the system has been stabilized and authorization is given by the Engineer.
10. Plug the treatment system inlet and outlet pipes to prevent construction runoff from entering the system. The systems shall be free of sediment prior to placement of media.
11. Where shown on the Drawings, the subbase aggregate shall be placed in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer prior to the placement of the system. Subbase aggregates shall meet the requirements of Section 31 23 33.
12. A licensed surveyor shall verify elevations to demonstrate that the subbase is level to within 0.5 percent prior to placement of the system. The subbase aggregate shall be re-leveled until acceptable elevation and grade has been achieved and is approved by the Engineer.
13. Non-shrink grout shall be used to provide a watertight seal in the lifting holes and around knock-outs for inlet and outlet pipes.
14. The concrete structure shall be tested for water tightness prior to backfilling.

B. Media Storage:

1. Media shall be stored, prepared, and installed in accordance with the manufacturer’s recommendations.
2. After media is placed, the system shall be covered to protect from contamination until the top lid is installed.
3. The top lid (where present) shall be sealed onto the box section using a non-shrink grout before backfilling.

3.02 TRAINING

A. The Contractor shall be aware that the Treatment Systems supplier shall arrange for one 8-hour day of operations training for Owner personnel provided by the manufacturer's representative during system startup, or activation. Contractor shall coordinate with the Treatment Systems supplier and accommodate this training.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. The Work under this section includes furnishing all labor, equipment, materials, and appurtenances required for a complete installation of the vortex-type hydrodynamic separators (HDS) as shown on the Drawings and specified herein. The hydrodynamic separators will be supplied by the Owner and procurement of these systems is not included in this Contract. Items to be supplied by the Owner are shown on the Drawings. All other items necessary to complete the Work shall be supplied by the Contractor.

1.02 REFERENCES

A. Not Used.

1.03 SUBMITTALS

A. Not Used.

1.04 QUALITY ASSURANCE

A. Field Quality Control:

1. The Engineer will:

a. Inspect materials prior to installation.

b. Observe installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. The Owner’s HDS supplier shall deliver all HDS materials to the West Sitcum Marine Terminal for storage by the Contractor. The specific delivery location shall be designated by the Engineer. Engineer shall coordinate delivery with the Contractor, who shall provide equipment for material offloading at the delivery site.

B. Protect all materials from damage during delivery, offloading, and storage. Cover UV sensitive materials if materials will be stored for more than one week. Storage surfaces should be free from dirt, mud and debris.

PART 2 - PRODUCTS

2.01 VORTEX-TYPE HYDRODYNAMIC SEPARATORS

A. Not Used.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. The Contractor shall exercise care in the storage and handling of the HDS components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be borne by the Contractor.

2. The HDSs shall be installed in accordance with the manufacturer’s recommendations and related sections of the Contract Documents. The manufacturer shall provide the Contractor installation instructions and offer guidance during the important stages of the installation as identified by the manufacturer at no additional expense.

3. The Contractor shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces. The Contractor shall trim all protruding lifting provisions.
4. System components shall be installed at the locations and elevations specified on the Drawings.
5. The Contractor shall be responsible for selecting the appropriate equipment to safely rig, lift, unload, and place the system.
6. Where shown on the Drawings, the subbase aggregate shall be placed in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer prior to the placement of the system. Subbase aggregates shall meet the requirements of Section 31 23 33.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Requirements for furnishing, installation, and connection of heat tracing system on all exposed process piping located near the Modular Wetland Treatment units and the Hydrodynamic Separator, and as needed for a complete and proper installation.

B. Refer to Section 26 05 00 - Common Work Results for Electrical, for quality assurance, submittal procedures, and other requirements.

1.02 SUBMITTALS

A. Supplier shall design complete heat trace system and submit heat trace design drawings for review.

B. Submit shop drawings and product data.

C. Submit operation and maintenance (O&M) manuals.

PART 2 - PRODUCTS

2.01 HEAT TRACE SYSTEMS

A. Provide a thermostatically controlled heat trace system as shown on the Drawings.

B. Control each heat trace system through a weatherproof thermostat.

C. Requirements for heat trace systems are as follows:

1. Design each heat trace system to automatically regulate process temperature to 45 degrees F liquid temperature when outdoor ambient conditions range from 10 to 45 degrees F and 20 MPH winds.

2. Base heat trace system design on the following:

a. Thermal conductivity of piping materials.

b. K value of insulation (Refer to Section 22 13 16 - Pipe and Fittings).

c. Heat output exceeding heat loss by a 1.5 safety factor at the specified performance requirement.

3. Self-regulating heat trace cable constructed, designed, and rated as follows:

a. 16 AWG copper bus wires.

b. Semi-conductive polymer core with electrical resistance variable with temperature.

c. Flame retardant, electrically insulating jacket.

d. Tinned copper braid.

e. Water and chemical resistant, flame retarding thermoplastic rubber insulation overjacket.

f. Operates on 120 V, 60 Hz ac power source as shown on the Drawings.

g. Maximum 150 degrees F maintained temperature.

4. Provide NEMA 4X power termination boxes, ambient sensing thermostats, splicing kits, end seal kits, and other accessories as required.

D. Acceptable Manufacturers:

1. Chromalox.
2. Delta-Therm.
3. Or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and field test heat trace system prior to installation of insulation.

3.02 FIELD QUALITY CONTROL

A. Conduct field tests as follows:

1. Continuity check.
2. Short circuit check.

END OF SECTION

PART 1 GENERAL

1.01 SUMMARY

A. Work Included:

1. The Contractor shall install all equipment provided by the Pump Station Supplier. See Section 33 44 13 - Pump Stations.

2. Provide all tools, equipment, materials, and supplies, and be responsible for all labor required to complete the installation, start-up, and operational testing of a complete and operable Instrumentation and Control (I&C) System as indicated on the Drawings and as specified herein.

3. Provide all the necessary equipment components and interconnections along with the services of manufacturers' engineering representatives necessary to ensure that the Owner receives a completely integrated and operational I&C system as herein specified.

4. Provide all terminations for wiring at field-mounted instruments, equipment enclosures, alarm, and status contacts.

5. Provide all instrumentation and control wire required for a fully functioning I&C system as shown on the Drawings, except for wire specifically specified in Division 26.

6. Refer to Division 26 for specific requirements for wire, conduit, grounding, and other electrical equipment.

1.02 RELATED SECTIONS

A. The work of all sections within Division 26 - Electrical and Division 40 - Process Interconnections is related to the work of this section. Other sections may also be related to the proper performance of this work. It is the Contractor's responsibility to perform all the work required by the Contract Documents.

1.03 REFERENCE STANDARDS

A. This section incorporates by reference the latest revision of the following documents. These references 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.

1. American National Standard Institute (ANSI) Publications:

a. Y14.15a - Drafting Practice.

b. C62.1 - Surge Arrestors.

2. International Society of Automation (ISA) Publications:

a. S5.4 - Instrument Loop Diagrams.

b. S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.

3. Underwriters Laboratories (UL): 508A - Industrial Control Equipment.

1.04 SUBMITTALS

A. As-Built Drawings: Submit a revised set of Shop Drawings that incorporate all change orders and modifications made during performance of the work. In addition to updated loop diagrams, interconnect diagrams, and elementary diagrams, submit equipment and device wiring

diagrams and other Drawings as necessary to depict the “as-built” condition of equipment. Include all installed field and panel conduit and piping/tubing runs and routing, tray systems, supports, mounting details, interconnection diagrams with cable, wire, tube, and termination numbers. Submit a copy of CADD produced drawings on magnetic media in AutoCAD or DWG format.

B. Operation and Maintenance Manuals: Furnish Operation and Maintenance Manuals, including instruction manuals and part lists, for equipment provided under Division 26 as required by Division 1. Obtain data from manufacturers, and format and bind as specified. Obtain distribution method instructions from the Owner or Owner’s representative.

1. Schedule: Deliver at least two copies of manuals in three-ring binders (8-1/2- by 11-inch format) not later than the equipment shipment date.

2. Contents:

a. Include in manuals not less than the following information, as applicable, for each instrument, equipment, subsystem, and/or control loop:

1) General introduction and overall description, purpose, functions, simplified theory of operations, etc.

2) Specifications sufficiently detailed for reordering exact duplicates of the original items.

3) Installation instructions, procedures, sequences, tolerances, and precautions.

4) Operational procedures.

5) Shutdown procedures.

6) Maintenance, calibration, and repair instructions.

7) Parts list and spare parts recommendations.

8) Calibration curves, rating tables, and any other data showing the relationship of the variable inputs and the calibrated output of all measuring devices and controlled equipment.

3. Format:

a. Use drawings and pictorials to illustrate the text to the extent necessary to ensure a clear, concise presentation. If manuals have been written to cover a family of similar instruments or equipment, strike out inapplicable information in a neat fashion or emphasize applicable portion by heavily weighted arrows, circles, or boxes; whichever provides the clearest and neatest presentation.

b. Group manuals by system control panels, including field instrumentation connected or associated with the panel. Where identical instruments are used in more than one control loop or subsystem, include only one instruction manual, per panel grouping; however, an index by tag number for all instruments shall identify its location in that manual.

c. Provide control loop and/or subsystem operational descriptions to identify the function of each instrument and its relation to the other instruments in the loop.

4. Binding: Bind each manual in a cover that indicates the panel or process area to which it applies, manufacturer’s name, local address, and telephone number, and year of purchase. Punch and bind manuals in standard three-ring binders and include system name and subcontractor’s name on binding.

C. Accessory and Maintenance Materials:

1. Submit data for the following items:

a. Special Tools and Accessories: Special tools, instruments, and accessories for maintaining instruments and equipment requiring periodic repair and adjustment as specified elsewhere herein. Also, furnish special lifting and handling devices for equipment requiring such devices.

b. Maintenance Materials and Spare Parts: Submit a list of manufacturer recommended spare parts for each item specified. Refer to other sections of these Specifications.

D. Test Reports:

1. Submit the following test reports as described herein:

a. Instrument Calibration Data Sheets (Paragraph 2.13).

b. Factory Testing of Control Panels (Paragraph 2.14).

c. Instrument Verification Report (Paragraph 3.08B).

d. Final Operational Testing (Paragraph 3.08C).

E. Demonstration and Final Operation Test Plan and Results: Submit a document that outlines all procedures to be used in final operational testing of instrument and control systems. Include a description of each system, the scope of testing, test methods and materials, testing instruments and recorders, a list of functional parameters to be recorded on each item, and Shop Drawings showing temporary bypasses, jumpers, and devices.

1.05 CONTRACTOR RESPONSIBILITIES

A. General:

1. The I&C equipment as specified in this division shall be considered an integrated system. Entire system installation including calibration, verification, start-up, operation testing, and training shall be performed by qualified personnel possessing all the necessary skills and equipment and who have had experience performing similar installations. Instrumentation and control systems drawings are diagrammatic only; it is the responsibility of the Contractor to obtain technical data, determine performance requirements, develop instrumentation-detail installation designs, and coordinate the selection of specified equipment with Contractor-supplied equipment to meet the design conditions stated.

B. Compatibility: See that all components of the instrumentation system, including equipment specified under other divisions, are completely compatible and function properly as a system. Provide such additional equipment, accessories, etc., as are necessary to meet these objectives at no cost to the Owner.

C. Coordination: For I&C components, devices, and systems specified in other divisions or shown on the Drawings:

1. Provide technical advice to mechanical and electrical subcontractors as necessary regarding their installation of instruments.

2. Verify the correctness of installation for all instruments.

3. Verify that the proper type, size, and number of control wires with their conduits are provided.

4. Verify that proper electric power circuits are provided for all components and systems.

5. Resolve all manufacturers' installation discrepancies between requirements and the detail requirements of the Drawings and Specifications.
6. Supervise final signal connections, both electric and pneumatic, to all process instrumentation and control equipment.
7. Adjust, start up, and test all process instrumentation and control equipment.

D. Performance: While the Drawings provide sufficient information to establish the form and function of the systems and their relationships, the responsibility for system integration and performance rests solely with the Contractor. The Engineer provides technical instruction and guidance where needed.

E. Site and Instrument Inspection: Inspect site for conformance to Drawings, paying special attention to space allocation and dimensions shown or required on Drawings. Inspect completed work and verify that it is ready for installation of instruments and equipment. Inspect each instrument and piece of equipment for damage, defects, completeness, and correct operation before installing.

1.06 QUALITY ASSURANCE

A. Standard of Quality: The Contractor shall provide equipment of the types and sizes specified that has been demonstrated to operate successfully. Provide equipment which is new and of recent proven design.

B. Conformance to acceptable standards, listing, or field inspection of all equipment and materials specified in Division 26 - Electrical, Division 40 - Process Interconnections, and all other divisions are required when indicated by the NEC, applicable safety codes, Washington State electrical and safety codes (including WAC 296-46B-010 [8]) and RCW 19.28, state and local electrical codes and regulations, and meeting the requirements of the Authority Having Jurisdiction (AHJ).

1. Examples of possible methods for meeting this requirement include the use of Underwriters Laboratories (UL) listed products and the UL 508 and UL 698 labeling of custom control assemblies.
2. The Contractor is responsible for determining whether the products and materials supplied meet these regulations and provide replacement with acceptable equipment, field inspection and labeling, or engineering evaluation to the satisfaction of the AHJ.
3. In the case of equipment and materials specified in Division 40 or other divisions where no substitutions allowed, the Contractor is responsible to supply the equipment in a configuration that meets the requirements of the AHJ through listing, field labeling, or other methods deemed acceptable by the AHJ.
4. The Contractor is responsible for all costs including modifications, engineering services, inspections, and labeling to satisfy the AHJ.
5. The terms Listed and UL Listed when used in this specification are requirements that the product be listed as defined in WAC 296-46B and meets all WAC, local, and AHJ requirements for listing by an approved Nationally Recognized Testing Laboratory (NRTL). Where the product is specified as Listed, substitution with products or materials that otherwise meet the requirement through field inspection or other means is not acceptable unless no Listed product is available. The Listed specification requirement, where indicated, does not exempt other products and materials, where not indicated, from the requirements of this paragraph.

6. Where existing I&C equipment is retained and/or modified for reuse in this project, the Contractor shall have responsibility for the modifications, engineering services, inspections, and field labelling of this existing equipment to satisfy the AHJ. The I&C subcontractor is responsible for all costs associated with the modification, engineering, inspection, and field labelling services.

C. Provide equipment with placards and labels (e.g., service entrance labels) where the NEC, WAC, local, and AHJ requirements require such labels.

1.07 SITE CONDITIONS

A. General:

1. Ambient Temperature Range: 0 to 100 degrees F.

2. Altitude: 40 feet above sea level.

3. Solar: Assume full solar gain for outdoor enclosures.

1.08 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases, or any element that could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Notify the Engineer in writing in the event that any equipment or material is damaged. Obtain prior favorable review by the Engineer before making repairs to damaged products.

PART 2 PRODUCTS

2.01 NAMEPLATES

A. Equipment nameplates shall conform to the requirements of Section 26 05 53 - Identification for Electrical Systems.

B. For each piece of equipment, provide a manufacturer’s nameplate showing its name, location, the pertinent ratings, and the model designation.

C. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings, and if not so indicated, with the equipment name. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the I&C subcontractor.

D. Provide CAUTION or SAFETY nameplates to alert operators of special conditions that may result in faulty equipment operations. Devices containing batteries that must be replaced periodically must be clearly identified. Nameplates are not required if the device senses and displays a low-battery warning.

2.02 EQUIPMENT OPERATING CONDITIONS

A. All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:

1. Electrical Power: 120 Vac plus 5 percent and minus 15 percent, 60 Hz, unregulated, except where specifically stated otherwise on the Drawings or in the Specifications, or when two wire, loop-powered devices are specified.

2. Field Instruments:

a. Outdoor Areas:

1) Ambient Temperature: Plus 0 degrees F to plus 100 degrees F.

2) Ambient Relative Humidity: 5 percent to 100 percent.

3) Weather: Rain, sleet, snow, and ice.

2.03 EQUIPMENT LOCATIONS

A. Provide equipment and materials suitable for the types of locations in which these items are located as defined under Division 26.

2.04 GENERAL FASTENING HARDWARE

A. All fasteners, anchors, clamps, supports, struts, and brackets shall be 316 stainless steel. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is 3/8 inch.

PART 3 EXECUTION

3.01 MOUNTINGS

A. Mount and install equipment as indicated. Mount field instruments in accordance with supplier's recommendation. Where mounted in control panels, mount according to requirements of that section.

B. All devices shall be accessible to operators for servicing, operating, reading, etc.

3.02 PROCESS CONNECTIONS

A. Process vessels, line penetrations, and root valves shall be furnished and installed under other divisions of these Specifications. Instrument tubing and valve manifolds are installed as part of this Specification.

3.03 FIELD WIRING

A. Ring out signal wiring prior to termination. Verify wire number and terminations are satisfactory as designated on the Loop and Interconnect Diagrams. Verify all terminations are tight and shields are uniformly grounded at one location.

3.04 ELECTROMAGNETIC INTERFERENCE (EMI)

A. Construction shall proceed in a manner which minimizes the introduction of noise (RFI/EMI) into the I&C system.

B. Cross signal wires and wires carrying ac power or control signals at right angles. Separate signal wires from wires carrying ac power or switched ac/dc control signals within control panels, terminal cabinets, telemetry equipment, multiplexer cabinets, and data loggers as much as possible. Provide the following minimum separations within such equipment unless indicated otherwise on the Drawings:

Power Wiring Capacity	Separation (Inches)
120 Vac or 10 A	12
240 Vac or 50 A	18
480 Vac or 200 A	24
4,160 Vac or 800 A	48

3.05 PREPARATION

A. Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing instruments and equipment. Maintain the areas in a broom clean condition during installation operations.

B. Panels shall be protected during construction to prevent damage to front panel devices and prevent dust accumulation in the intervals. Other protective measures (lamp, strip heaters, etc.) shall be included as weather conditions dictate.

3.06 INSTALLATION

A. Provide all tools, equipment, materials, and supplies, and be responsible for all labor required to complete the installation, start-up, and operational testing of a complete and operable Instrumentation and Control (I&C) System as indicated on the Drawings and as specified herein.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall install all equipment provided by the Pump Station Supplier. See Section 33 44 13 - Pump Stations.

1.02 RELATED SECTIONS

A. The work of all sections within Division 40 - Process Interconnections is related to the work of this section. Other sections may also be related to the proper performance of this work.

1.03 REFERENCE STANDARDS

A. This section incorporates by reference the latest revision of the following documents. These references are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of a listed document, the requirements of this section shall prevail.

1. National Electrical Manufacturers Association (NEMA) Publications:

a. ICS1: General Standards for Industrial Controls and Systems.

b. ICS2: Standards for Industrial Control Devices, Controllers, and Assemblies.

c. ICS4: Terminal Blocks for Industrial Control Equipment and Systems.

d. ICS6: Enclosures for Industrial Controls and Systems.

2. UL Underwriters Laboratories:

a. 508: Industrial Control Equipment.

3. NEC: National Electrical Code.

4. FS W-C-375: Circuit Breakers, Molded Case, Branch Circuit and Series Service, Series Trip.

PART 2 - PRODUCTS

2.01 GENERAL

A. All products in this specification have been provided by the Pump Station Supplier.

PART 3 - EXECUTION

3.01 INSTALLATION AND COMMISSIONING

A. The Contractor shall include in the scope of work the final inspection, testing, configuration, and commissioning of the completed installation.

B. Installation, testing, calibration, validation, start up, and instruction shall be in accordance with Section 40 61 13 - Process Control System General Provisions.

C. Install each control panel level and plumb and secure by the favorably reviewed seismic mounting method. Doors shall swing freely and close tightly. All damage to the enclosure finishes during installation shall be touched up at the job site as approved.

D. Panel shall be free-standing, mounted to a concrete equipment pad.

E. After installation, repair any damage to the structure, components, or finish to the satisfaction of the Engineer. Clean all nameplates.

F. Use protective sheet metal covers, canvas, heat lamps, etc., as needed to ensure equipment protection to keep out foreign matter, dust, dirt, debris, or moisture.

3.02 FIELD QUALITY CONTROL

A. Following installation of all electrical devices, coordinate with Owner's representative to demonstrate correct wiring and operation of all control devices.

3.03 DEMONSTRATION AND TRAINING

A. After checkout of all electrical and control systems is complete, demonstrate that all control equipment is operating correctly.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall install all equipment provided by the Pump Station Supplier. See Section 33 44 13 - Pump Stations.

1.02 RELATED SECTIONS

A. The work of all sections within Division 40 - Process Interconnections is related to the work of this section. Other sections may also be related to the proper performance of this work.

PART 2 - PRODUCTS

2.01 PROCESS INSTRUMENTATION

A. All products in this specification have been provided by the Pump Station Supplier. The schedules below are provided for reference to indicate the instrumentation that is to be installed by the Contractor.

B. Provide Float Level Switch (LS) level measurement devices to comply with Section 40 72 73 - Level Switches as follows:

Tag	Service	Power Supply	Output
LSLL-A1	Low Low Wet Well Level Float Switch	120 Vac	Dry Contact
LSL-A2	Low Wet Well Level / Pump OFF Float Switch	120 Vac	Dry Contact
LSH-A3	High Wet Well Level / Pump ON Float Switch	120 Vac	Dry Contact
LSHH-A4	High High Wet Well Level Float Switch	120 Vac	Dry Contact
LSH-A5	High HDS Level Float Switch	120 Vac	Dry Contact
LSH-A6	High Overflow Basin Level Float Switch	120 Vac	Dry Contact

C. Provide Pressure Gauge (PG) measurement devices as shown on the drawings and as follows:

Tag	Loop No.	Service	Power Supply	Output	Calibration Range
PG	A1	Pump No. 1 Discharge Pressure Gauge	N/A	N/A	1-150 PSI
PG	A2	Pump No. 2 Discharge Pressure Gauge	N/A	N/A	1-150 PSI

D. The instrumentation shown above are for Basin A only. Basins B and C will have the same instrumentation. Label equipment at each basin using the associated alphabetic identifier, i.e., LSH-B5 and LSH-C5.

PART 3 - EXECUTION

3.01 INSTALLATION AND COMMISSIONING

A. The Contractor shall include in the scope of work the final inspection, testing, configuration, and commissioning of the completed installation.

B. Installation, testing, calibration, validation, start up, and instruction shall be in accordance with Section 40 61 13 - Process Control System General Provisions.

C. After installation, repair any damage to the structure, components, or finish to the satisfaction of the Engineer. Clean all nameplates.

D. Use protective sheet metal covers, canvas, heat lamps, etc., as needed to ensure equipment protection to keep out foreign matter, dust, dirt, debris, or moisture.

3.02 FIELD QUALITY CONTROL

A. Following installation of all electrical devices, coordinate with Owner’s representative to demonstrate correct wiring and operation of all control devices.

3.03 DEMONSTRATION AND TRAINING

A. After checkout of all electrical and control systems is complete, demonstrate that all control equipment is operating correctly.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall install all equipment provided by the Pump Station Supplier. See Section 33 44 13 - Pump Stations.

1.02 RELATED SECTIONS

A. The work of all sections within Division 40 - Process Interconnections is related to the work of this section. Other sections may also be related to the proper performance of this work.

1.03 REFERENCE STANDARDS

A. This section incorporates by reference the latest revision of the following documents. These references are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of a listed document, the requirements of this section shall prevail.

1. NEMA: National Electrical Manufacturers Association.
2. NEC: National Electrical Code.

PART 2 - PRODUCTS

2.01 GENERAL

A. All products in this specification have been provided by the Pump Station Supplier.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide installation, testing, calibration, verification, and start up in accordance with the manufacturer’s instructions and requirements.

B. Installation, testing, calibration, verification, and start-up instructions shall be in accordance with Section 40 61 13 - Process Control System General Provisions.

END OF SECTION