JORDAN VALLEY WATER CONSERVANCY DISTRICT

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WEST JORDAN, UTAH

JORDAN VALLEY WTP RECLAIM WATER AND SOLIDS HANDLING IMPROVEMENT PROJECT

ENGINEER PROJECT NO. 10851A.10
JVWCD PROJECT NO. 4072

CONTRACT/TECHNICAL SPECIFICATIONS

BID SET

VOLUME 2 OF 4
DIVISIONS 01 to 05

JUNE 2020

Digitally signed by Alan M. Domonoske
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JORDAN VALLEY WATER CONSERVANCY DISTRICT

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SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Detailed description of the Work.

1.02 THE WORK

A. The Work consists of: improvements to the reclaim water and solids handling process, including construction of a weir vault; pump and pipe modifications to recycle pump station number 1; upgrades to existing variable frequency drives in recycle pump station number 2; replacement of sludge pipeline from existing sludge lagoons; installation of new pump discharge pipeline to existing sludge lagoons; concrete lining existing reclaim ponds; miscellaneous civil and electrical/instrumentation work.

1.03 LOCATION OF PROJECT

A. The Work is located at 15305 S 3200 W, Herriman UT 84065.

1.04 ACTIVITIES BY OTHERS

A. Owner, utilities, and others may perform activities within Project area while the Work is in progress.
   1. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

1.05 COORDINATION OF WORK

A. Contractor shall have a preconstruction video made that records the project sites (with the Engineer and Owner present) including all concrete and asphalt pavements, curb and gutter, fencing to remain, structures to be demolished, and existing structures and facilities that are to be modified.
   1. The original and 2 copies of the DVD shall be turned over to Engineer and Owner prior to beginning construction activities.
   2. The format of the video file on the DVD shall be 1 file that can be played on a desktop in the windows media player.
   3. The video shall clearly identify existing site and structural conditions prior to construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01116

CONTRACT DOCUMENT LANGUAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Explanation of arrangement, language, reference standards and format.

1.02 REFERENCES

A. Construction Specifications Institute (CSI):
   1. MasterFormat™.
   2. SectionFormat™.
   3. PageFormat™.

1.03 PROJECT MANUAL ARRANGEMENT

A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

1.04 CONTRACT DOCUMENT LANGUAGE

A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section.
   1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.

B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all."
   1. Assume missing portions by inference.

C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
   1. When used as an appositive after designation of product, colons are used in place of words "shall be."

F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.

G. Words "Contractor shall" are implied when direction is stated in imperative mood.

H. Term "products" includes materials and equipment as specified in Section 01600 - Product Requirements.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

1.02 SUBMITTALS

A. Baseline Schedule with MOP tasks.

B. Method of Procedure (MOP) Form.

C. Method of Procedure (MOP) Log.

D. Progress Schedule with MOP tasks.

1.03 GENERAL CONSTRAINTS ON WORK AND SCHEDULING OF WORK

A. Perform abandoned pipe Work as specified in Section 01738 - Selective Alterations and Demolition.

B. Water projects:
   1. Conduct Work such that the Owner's ability to meet its customer's demands for treated drinking water shall not be impaired or reduced in terms of the required quantity or quality of treated water. Do not impair the operational capabilities of essential elements of the treatment process or reduce treatment capacity below levels sufficient to meet demands for water throughout the contract time. The quantities of and quality of treated water required are described in this Section.
   2. Conduct commissioning activities as specified in Section 01756 - Commissioning in a manner that will not impair capabilities of essential elements of the treatment process or reduce treatment capacity below levels sufficient to meet demands for water throughout the contract time. The quantities of and quality of treated water required are described in this Section.
   3. The status of the treatment plant shall be defined as "operational" when the plant is capable of meeting the Owner's customer's demands for treated drinking water in terms of the required quantity or quality of treated water as defined in this Section.

C. Instrumentation and controls process performance testing:
   1. After the Process Operational Period, test PCIS system as specified in Section 01756 - Commissioning.

1.04 SHUTDOWN AND CONSTRUCTION CONSTRAINTS

A. General shutdown constraints:
   1. Execute the Work while the existing facility is in operation.
   2. Some activities may be accomplished without a shutdown.
   3. Apply to activities of construction regardless of process or work area.
   4. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
   5. Organize work to be completed in a minimum number of shutdowns.
   6. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
   7. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
   8. Final determination of the permitting of shutdowns will be the sole judgment of the Owner.
   9. Owner maintains the ability to abort on the day of the scheduled shutdown.

B. Shutdown activities:
   1. Scheduling:
      a. The Construction Manager and the Plant Personnel will evaluate the request based on the plant's ability to reliably meet capacity demands.
      b. Do not begin alterations until Construction Manager’s written permission has been received.
      c. All shutdown durations presented in this Section are inclusive of drain and refill time and will be measured from the time the plant is no longer producing water until the time the plant resumes producing water. Contractor shall provide adequate time in schedules for draining and cleanup of basins.
         1) The Contractor may assume 8 hours is required for draining and refilling.
   2. Unplanned shutdowns due to emergencies are not defined in this Section.

C. Constraints for plant shutdown:
   1. The work sequencing and description of critical events provided in this Section are provided to assist the Contractor in scheduling and undertaking the Work. They do not include all items affecting completion of the Work but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure compliance with water quality permit requirements, and Owner’s water quality standards.
   2. The following constitute a plant shutdown:
      a. Full plant shutdown:
         1) Shutdown of the entire plant where the plant is not producing water.
      b. Backwash system shutdown:
         1) Shutdown of backwash system such that backwash waste washwater is not sent to the FWW clarifier, reclaim ponds, or Reclaim Pump Station No. 1 and 2. However, Contractor shall expect and address nuisance water from leaking valves into the backwash FWW system during a Backwash system shutdown.
      c. Sludge return shutdown:
         1) Shutdown of the sludge return system that comes from the sludge lagoons, while allowing the plant to continue to produce water.

d. Reclaim pond shutdown:
    1) Shutdown of one reclaim pond while the other remains in service.
3. April 1, 2020 through September 30, 2020:
    a. No plant shutdowns are allowed.
4. November 1, 2020 through February 28, 2021:
    a. Selected full plant shutdowns are allowed for up to 10 hours with 3 day prior notice and a minimum of 3 days between shutdowns.
    b. Backwash shutdowns are allowed for up to 24 hours with 1 day prior notice and a minimum of 1 day between shutdowns.
5. October 1, 2020 through March 30, 2021:
    a. Reclaim pond shutdowns are allowed for this time period.
        1) Contractor can begin to haul sludge from the first pond to the monofill onsite, as described herein. The second pond must remain in service until construction of the first pond is finished.
        2) Contractor shall assume a minimum 3-week period for the Owner to decant the second pond to allow the solids to reach a semi-solid state before Contractor begins hauling solids, as described herein.
6. February 15, 2021 to March 15, 2021:
    a. One sludge return shutdown for a maximum of 2 weeks is allowed during this period.
7. A plant shutdown may be required for the following activities:
    a. Installation of 24-inch sludge (SL) pipeline from the sludge lagoons to 36-inch waste washwater (WW) tie-in.
    b. Modifications to the existing reclamation ponds
    c. Recycle Pump Station No. 1:
        1) Tie-in to new 12-inch SL pipe
    d. Weir Vault:
        1) 48-inch WW demolition and new connections
        2) Installation of new 36-inch BFV and 36-inch WW section of pipe.
    e. Some of the above activities may be handled by a backwash system shutdown rather than a full plant shutdown.

D. Dewatering of existing process and disposal of residue:
1. When the Owner has turned the process unit over to the Contractor for modification or temporary use, the Contractor is responsible for costs and procedures required to dispose of liquid, solids, etc. in the Reclaim ponds, piping, and Recycle Pump Station No. 1.
    a. Reclaim Ponds:
        1) Sludge from the first Reclaim pond can be removed via a front-end loader and disposed of at the onsite monofill. Monofill is located approximately 0.25 miles east of the reclaim ponds. Assume 2 feet of slurry at approximately 10 percent solids.
        2) Owner will drain the second Reclaim pond. Contractor to allow a 3-week period for decanting.
            a) After decanting of the second pond, haul and dispose of the slurry to the onsite monofill. Assume 2 feet of 10 percent solids.
    b. Recycle Pump Station No. 1.
        1) Assume on average 12 inches of sludge to be removed via Vac truck, hand crews, or means of Contractor’s choosing.

1.05 METHOD OF PROCEDURE (MOP)

A. MOP Instructions: See Appendix A.

B. Prepare MOP for the following conditions:
   1. Shutdowns, diversions, and tie-ins to the existing facility.
   2. Process start-up activities.
   3. Power interruption and tie-ins.
   4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.
   5. Process constraints requiring interruption of operating processes or utilities.

C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.

D. Submit Baseline Schedule, as specified in Section 01321 - Schedules and Reports, with proposed MOPs.

E. Submit MOP Log at construction progress meetings.

F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.

G. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.06 COMPLIANCE WITH DRINKING WATER PERMIT

A. The existing facility is operating under the terms of a Drinking Water permit issued by the State of Utah. This permit specifies the water quality limits that the plant must meet prior to discharge of finished water. A copy of the existing permit is on file for review at the Owner's office.

B. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.

C. Bear the cost of penalties imposed on the Owner for water quality violations caused by actions of the Contractor.

1.07 REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

A. Facilities or conditions required to keep the Jordan Valley Water Treatment Plant (JVWTP) operational include, but are not limited to, the following:
   1. Electrical power including transformers, distribution wiring, and motor control centers.
   2. Raw (untreated) water:
      a. Existing pipelines and raw water reservoir.
   3. Piping for conveyance of raw, partially treated and finished water between treatment or storage units and basins and to the finished water reservoirs.

4. A means of adding coagulant chemicals through existing flash mix pumps.
5. Chemical storage, metering, conveyance, and control facilities:
    a. Provided with existing storage tanks for chlorine, primary coagulant, and caustic soda; chemical metering pumps; chlorine residual analyzers; and chemical solution piping at various locations in the plant.
    b. Plant water is required continuously to provide chlorination.
    c. Continuous addition of chemicals is required during plant operations.
    d. The ability to continuously apply chlorine following filtration is required.
    e. All chemical offloading.
6. Flocculation.
7. Sedimentation basins.
8. Filters.
9. Backwash pumps.
10. Waste washwater (WW) reclamation:
    a. Water used to backwash (waste washwater) the filters is conveyed via pipelines to the existing reclamation ponds.
    b. The WW is clarified in the reclamation ponds and returned to Recycle Pump Station No. 2 to be recycled back to the front of the plant.
    c. Following the upgrades, the new weir vault will allow filter WW to flow either to the reclamation ponds or to the existing clarifier. WW from the clarifier will drain to Recycle Pump Station No. 1, where new pumps and piping can convey the WW to the sludge lagoons.
11. Sludge disposal:
    a. Existing piping conveys sludge from the sedimentation basins to the sludge lagoons.
    b. Following the upgrades, an additional pipeline will pump WW to the sludge lagoons. New piping from the sludge lagoons will then convey decanted water to Recycle Pump Station No. 2 to be pumped to the front of the plant.
12. Plant water.
13. Plant air.
14. Laboratory facilities.
15. Office, toilets, and washrooms.
16. Fencing and gates.
17. Lighting.
18. Heating, ventilation, and air conditioning.
19. Instrumentation, meters, controls, and telemetry equipment.
20. Safety equipment and features.
21. Parking for District employees and vehicles required for operation and maintenance of the JVWTP.
22. Telephone system.
23. Storm drainage.
24. Natural gas service.

B. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.

C. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
    1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

1.08 OPERATIONS AND MAINTENANCE ACCESS

A. Provide safe, continuous access to process control equipment for plant operations personnel.

1.09 UTILITIES

A. Provide advance notice to and utilize services of Blue Stake for location and marking of underground utilities operated by utility agencies other than the Owner.

B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

C. New yard utilities were designed using existing facility drawings.
   1. Field verification of utilities locations was not performed during design.
   2. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
   3. Pipe alignments as indicated on the Drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A
"Method of Procedure" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	No later than 7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	No later than 7 days prior to work
Contractor	6. Complete Readiness Checklist.	No later than 5 days prior to work
Contractor	7. Complete Safety Checklist.	Immediately prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submit 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete work.

Contractor complete work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ **Date:** _____

Contractor: _____ **Carollo Project No.:** _____

Project Name: _____ **Submittal No.:** _____

Submittal Title: _____ **Spec/Dwg. Reference:** _____

MOP #	Task Title *(Provide <10 word title)*:	Submittal Date: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY START: *(Date/Time)* END: (Date/Time)

REQUESTOR:

PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:

NOTIFY ☐ Control Room, Phone ☐ Security, Phone

BUILDING: LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT/TOOLS: *(pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:

☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect Emergency	☐	Natural Gas	☐	Storm Drain	☐	

REVIEWER'S INSTRUCTIONS / COMMENTS: _____

☐ PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:

	Full Name (printed)	Signature	Phone	Date
Submitted By				
System Owner				
Reviewer (if needed)				

Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

READINESS CHECKLIST
(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____
2. Review work plan: _____
3. Review contingency plan: _____

SAFETY CHECKLIST
(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____.
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

Method of Procedure (MOP) Log
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (yes/no)
001					
002					
003					

SECTION 01210

ALLOWANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Listing of allowance items:
      a. Related responsibilities of Contractor and procedures.

1.02 ALLOWANCE AMOUNTS

A. Include following amounts in Contract Price:
   1. $20,000 for rehabilitation of vertical turbine pump (remaining east wet well pump that was not previously refurbished). Shipping associated with pump rehabilitation is to be included in the allowance. Removal of the existing pump, installation of the pump in new location, testing, and commissioning of the pump are not included in this allowance.
   2. $35,000 Reclaim Pond inlet box rehabilitation. The reclaim box inlet has two manual gates that work well but they do not have electric actuators and some concrete in the box associated with the gates is cracking. This allowance is for the gates to be removed, concrete repaired, gates to be reinstalled, and new electric actuators to be installed and integrated into the plant control system.

1.03 COSTS INCLUDED AND EXCLUDED IN ALLOWANCES

A. Costs included in allowances for furnishing products only:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes and fees.

B. Costs included in Contract Price, but not included in allowances for furnishing products only:
   1. Handling at site, including uncrating and storage.
   2. Protection from elements, theft, and damage.
   3. Labor, installation, testing, and finishing.
   4. Other expenses required to complete installation.
   5. Overhead and profit.

C. Costs included in allowances for furnishing and installing products:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes.
   4. Handling at site, including uncrating and storage.
   5. Protection from elements and from damage.
   6. Labor, installation, testing, and finishing.
   7. Other expenses required to complete installation.

1.04 DUTIES OF CONTRACTOR IN PROVIDING PRODUCTS BY ALLOWANCE

A. Advise Engineer at least 60 days in advance of purchase date necessary to avoid impacts to Progress Schedule.

B. Obtain proposals from suppliers, including:
   1. Quantity.
   2. Complete description of product and services provided under allowance.
   3. Unit cost.
   4. Total amount of purchase.
   5. Taxes and delivery charges.

C. On notification of selection, enter into purchase agreement with designated supplier.

D. Arrange for delivery and unloading.

E. Install products in accordance with Contract Documents.

1.05 ADJUSTMENT OF COSTS

A. When actual cost is more or less than amount of allowance, Contract Price will be adjusted by Change Order.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01220

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for measurement and payment of Work under this Contract for lump sum items and unit prices.

1.02 REFERENCES

A. Occupational Safety and Health Administration (OSHA).

1.03 LUMP SUM ITEMS

A. Item 1: Mobilization/General Conditions:
   1. Measurement:
      a. Limit amounts included under mobilization to the following items:
         1) Moving on the site any equipment required for first month operations.
         2) Installing temporary construction power, wiring, and lighting facilities.
         3) Establish and submit fire protection plan and safety program.
         4) Provide temporary facilities as specified in Section 01500 - Temporary Facilities and Controls.
            a) Providing on-site sanitary facilities and potable water facilities as specified.
            b) Providing field office trailers for the Contractor and the Engineer, complete with specified furnishings and utility services including telephones and internet.
            c) Developing construction water supply.
         5) Arranging for and erection of Contractor's work and storage yard, employee parking facilities, and entrance road.
         6) Submit required insurance certificates and bonds.
         7) Obtaining required permits, licenses, and fees.
         8) Submit preliminary schedule of values of the Work.
         9) Submit preliminary schedule and develop baseline schedule.
         10) Submit cash flow in tabular and graphical formats.
         11) Submit Schedule of Submittals.
         12) Submit standardized traffic maintenance and control plans.
         13) Post OSHA, Department of Labor, state, and other required notices.
         14) Location and flagging of construction and clearing.
         15) Submit Contractor's quality control plan.
         16) Submit pre-construction photographs and videos.
         17) Provide and erect the project sign.
         18) Have Contractor's project manager and/or general superintendent on job site full-time.
   2. Payment:
      a. Furnish data and documentation to substantiate the amounts claimed under mobilization costs.

b. Payment for mobilization shall not be made until mobilization items listed above have been completed as specified.
c. Limit price for mobilization to no more than 4 percent of Contract Price.
d. Lump sum.

B. Item 2: Commissioning:
1. Measurement:
a. Requirements as specified in Section 01756 - Commissioning, including planning, commissioning, and start-up phases for the Project devices, components, equipment, and/or facility.
2. Payment:
a. Shall not be less than 3 percent of Contract Price.
b. Lump sum.

C. Item 3: Demobilization:
1. Measurement:
a. Removal of temporary facilities as specified in Section 01500 - Temporary Facilities and Controls.
b. Completion of closeout submittals as specified in Section 01770 - Closeout Procedures.
2. Payment:
a. Shall not be less than 3 percent of Contract Price.
b. Lump sum.

D. Item 4: Lump sum Items:
1. Measurement:
a. Includes costs including Contractor's fee for overhead and profit for continuous, full-time management of the Contract as described in the Contract Documents, covering a period of time not less than from the Notice to Proceed through the entire length of the allowable Contract Times specified in the Contract Documents.
b. Includes individual Bid Items specified in this Section.
2. Payment:
a. Lump sum.

1.04 UNIT PRICE ITEMS (NOT USED)

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01260

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for executing a change in the Work.

1.02 PRELIMINARY REQUIREMENTS

A. Change Order Cost Basis Summary Form:
   1. Submit a sample to Engineer for review within 15 calendar days following Notice to Proceed.
      a. Items will be reviewed and their value, percentage, or calculation method mutually agreed to by the Contractor and Owner prior to executing a Change Order on the Project.
   2. Used by the Contractor for pricing each Change Order required for additions, deletions, or revisions in the Work.
   3. Include the following information:
      a. Agreed upon markups, percentages, and procedures for calculating all surcharges, etc. associated with the Cost of the Change Order Work.
      b. References for unit price information and special unit price information.
      c. Attachments with the following information:
         1) Certified labor rates breakdown.
         2) Equipment rates.
         3) Bond and insurance rates (PI&I).

1.03 REQUEST FOR INFORMATION OR INTERPRETATION (RFI)

A. Contractor may issue RFIs to request interpretation of the documents or to request for information that may be missing.

B. General Instructions:
   1. Use RFI Form as specified in Document 00632 - Request for Information or Interpretation (RFI).
      a. Use of other RFI Forms is acceptable if the form includes the information in the form provided in the referenced form, at a minimum.
   2. Number RFIs consecutively.
      a. Add a consecutive letter to the RFI number on modified submittals of the same RFI (i.e., RFI 4B).
   3. Provide RFI for 1 item.
      a. There may be exceptions when multiple items are so functionally related that expediency indicates review of the group of items as a whole.
      b. RFIs with multiple items will be rejected without review.
   4. Contractor sign and date RFIs indicating review and approval.
      a. Contractor’s signature indicates that they have satisfied RFI review responsibilities and constitutes Contractor's written approval of RFI.

b. RFIs without Contractor's signature will be returned to the Contractor unreviewed. Subsequent submittal of this information will be counted as the first resubmittal.

C. Engineer will render a written clarification, interpretation, or decision on the issue submitted or initiate an amendment or supplement to the Contract within 21 days.
   1. In the event the Contractor identifies an RFI as critical to the progress of the project, Engineer will make every effort to reduce the RFI response time.

1.04 PRELIMINARY PROCEDURES

A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor including the following information:
   1. Detailed description of the Change, Products, and location of the change in the Project.
   2. Supplementary or revised drawings or specifications.
   3. Projected time span for making the change, and a specific statement if overtime work is authorized.
   4. A specific period of time during which the requested price will be considered valid.
   5. Such request is for information only, and is not an instruction to execute the changes, or to stop work in progress.

B. Contractor may initiate changes by submitting a Change Proposal to Engineer containing the following:
   1. Description of proposed changes.
   2. Reason for making changes.
   3. Specific period of time during which requested price will be considered valid.
   4. Effect on Total Contract Cost and/or Contract Time.
   5. Documentation supporting any change in Total Contract Cost and/or Contract Time, as appropriate.

1.05 WORK CHANGE DIRECTIVE AUTHORIZATION

A. In lieu of a Request for Proposal (RFP), Engineer may issue a Work Change Directive Authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. Authorization will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change, and will designation method of determining any change in the Contract Sum and/or the Contract Time, as appropriate.

C. Owner and Engineer will sign and date the Work Change Directive Authorization as authorization for the Contractor to proceed with the changes.

D. Contractor may sign and date the Work Change Directive Authorization to indicate agreement with the terms.

1.06 DOCUMENTATION OF CHANGE PROPOSALS

A. Change proposal:
   1. Support with sufficient substantiating data to allow Engineer to evaluate the quotation.
      a. Lump sum.
      b. Unit prices: Use previously established unit prices.
      c. Time-and-material/force account basis:
         1) Name of the Owner's authorized agent who ordered the work, and date of the order.
         2) Dates and times work was performed, and by whom.
         3) Time record, summary of hours worked, and hourly rates paid.
         4) Receipts and invoices for:
            a) Equipment used, listing dates and times of use.
            b) Products used, listing of quantities.
            c) Subcontracts.
   2. Provide additional data to support time and cost computations:
      a. Labor required.
      b. Equipment required.
      c. Products required:
         1) Recommended source of purchase and unit cost.
         2) Quantities required.
      d. Taxes, insurance, and bonds.
      e. Credit for work deleted from Contract, similarly documented.
      f. Overhead and profit.
      g. Justification for change to Contract Time.

1.07 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS

A. Engineer will prepare each Change Order and Field Order.

B. Change Orders:
   1. Will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
   2. Will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.
   3. Recommendation of Change Proposal is indicated by Engineer's signature.
   4. Upon signature and execution by Owner, the Change Proposal becomes a Change Order altering the Contract Time and Total Contract Cost, as indicated.
      a. Owner's Representative will transmit one signed copy each to Contractor and Engineer.
   5. Contractor may only request payment for changes in the Work against an approved Change Order.
   6. If either Engineer or Owner's Representative disapproves the Change Proposal, the reason for disapproval will be stated.
      a. A request for a revised proposal or cancellation of the proposal will be shown.

C. Field Orders:
   1. Order minor changes in the Work without changes in Contract Price or Contract Times.

1.08 LUMP-SUM/FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's Proposal Request and Contractor's responsive Change Proposal as mutually agreed between Owner and Contractor.
   2. Contractor's Change Proposal for a change, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

C. Contractor will sign and date the Change Order to indicate agreement with the terms.

1.09 UNIT PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's definition of the scope of the required changes.
   2. Contractor's Change Proposal for a change, recommended by Engineer.
   3. Survey of completed work.

B. The amounts of the unit prices to be:
   1. Those stated in the Contract.
   2. Those mutually agreed upon between Owner and Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the work:
   1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.
   2. Contractor will sign and date the Change Order to indicate agreement with the terms.

D. When quantities of the items cannot be determined prior to start of the work:
   1. Engineer or Owner will issue a Work Change Directive authorization directing Contractor to proceed with the change on the basis of unit prices, and will cite the applicable unit prices.
   2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.
   3. Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.

E. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

F. Contractor will sign and date the Change Order to indicate their agreement with the terms.

1.10 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK CHANGE DIRECTIVE AUTHORIZATION

A. Engineer will issue a Work Change Directive for the Owner's signature authorizing Contractor to proceed with the changes.

B. At completion of the change, Contractor shall submit itemized accounting and supporting data as specified in this Section.

C. Engineer will determine the allowable cost of such work, as provided in the Contract Documents.

D. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

E. Contractor will sign and date the Change Order to indicate their agreement.

1.11 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Applications for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time. Revise subschedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01292

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Print out Schedule of Values from accepted Preliminary or Baseline Schedule submitted and accepted under Section 01321 - Schedules and Reports.

B. Schedule of Values shall be a listing of all cost loaded, on-site construction activities from the progress schedule, listed in numerical order, showing that the sum total of all cost-loaded activities equal the Contract value.

C. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all cost-loaded activities continuously equal the current Contract value.

D. Prepare Schedule of Values identifying costs of Major Items of Work and other costs shown in sample included at end of this Section.

E. Divide the work into following Major Items of Work:
   1. Mobilization/General Conditions.
   2. Contractor's Required QA/QC Testing.
   3. Weir Vault.
   4. Recycle Pump Station No. 1 Pump and Pipe Modifications.
   5. Recycle Pump Station No. 2 VFD Replacement.
   6. Reclaim Pond Modifications.
   7. 14-inch Backwash Return (BWR) Pipeline Installation.
   8. Lagoon Sludge (SL) Return Pipeline/Manhole Removal and Installation.
   9. Miscellaneous civil, electrical, and instrumentation work items not included in previous items.
   10. Commissioning.
   11. Demobilization.
   12. Allowance Items.

F. Assign prices to Major Items of Work which aggregate the Contract Price. Base prices on costs associated with scheduled activities based on the Project Schedule for each Major Item of Work.

1.03 SUBMITTALS

A. Submit preliminary Schedule of Values.

B. Submit corrected Schedule of Values within 10 days upon receipt of reviewed Schedule of Values, but no later than 10 days prior to anticipated submittal of first Application for Payment.

C. Upon request, support prices with data that will substantiate their correctness.

D. If activities are added or removed from the Progress Schedule, revise the Schedule of Values and resubmit.

1.04 SAMPLE SCHEDULE OF VALUES

A. Following is an acceptable form for Schedule of Values:

(SAMPLE ONLY) SCHEDULE OF VALUES		
NO.	DESCRIPTION OF ITEM	LUMP SUM COST
1	LUMP SUM ITEM TITLE	
1.A	Mobilization	
1.B	General earthwork and grading	
1.C	Miscellaneous yard piping List Major Items of Work identified in Article 1.02 Paragraph C and number consecutively	
1.D	Electrical work Schedule of Values as specified in Section 16050 - Common Work Results for Electrical	
1.E	Major Items of Work (for example, pump station, headworks, etc.)	
1.F	General instrumentation work not included on Major Items of Work	
1.G	Commissioning	
1.H	Demobilization	
1.I	Miscellaneous work items and other prices not included in previous items and necessary to complete the Work	
	TOTAL LUMP SUM	

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01294

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for preparation and submittal of Applications for Payment.

1.02 FORMAT

A. Develop satisfactory spreadsheet-type form generated by downloading cost data from the Progress Schedule.
   1. Submit payment requests using the Payment Application and Certificate Form.

B. Fill in information required on form.

C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
   1. Identify change order by number and description.
   2. Provide cost of change order in appropriate column.

D. After completing, submit Application for Payment.

E. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.

F. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

A. Provide Substantiating Data with cover letter identifying:
   1. Project.
   2. Application number and date.
   3. Detailed list of enclosures.
   4. For stored products with item number and identification on application, description of specific material, and proof of insurance coverage for offsite stored products.
   5. Submit “certified” payroll, if applicable.

1.04 SUBMITTALS

A. Submit final copies of the Payment Application using Web Based Construction Document Management system (See Section 01322 - Web Based Construction Document Management).

1.05 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.

D. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.

E. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.

F. Payment period:
   1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
   2. Submit Application for Payment to Engineer no later than the 25th of each month.
   3. Engineer will finalize and submit recommendation for Application for Payment to Owner within 7 days after receipt of each Application of Payment to allow time for processing and approval.

1.06 COST SUMMARIES

A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01312

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
   1. Qualifications of Meeting Participants.
   2. Pre-construction Conference.
   3. Progress Meetings.
   4. Pre-Installation Meetings.
   5. Schedule Update Meetings.
   6. Quality Control Meetings.
   7. Pre-Shutdown Meetings.
   8. Pre-Process Start-up Meetings.
   9. Electrical and Instrumentation Coordination Meetings.
   10. Close-out meeting.
   11. Post Construction Meeting.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

1.03 PRE-CONSTRUCTION CONFERENCE

A. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, Engineer will arrange pre-construction conference in place convenient for most invitees.

B. Pre-construction Conference invitees: Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to agenda.

C. Engineer will preside at conference.

D. Purpose of conference: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.

E. Agenda will include:
   1. Adequacy of distribution of Contract Documents.
   2. Distribution and discussion of list of major subcontractors and suppliers.
   3. Proposed progress schedules and critical construction sequencing.
   4. Major equipment deliveries and priorities.
   5. Project coordination.

6. Designation of responsible personnel.
7. Procedures and processing of:
    a. Field decisions.
    b. Proposal requests.
    c. Submittals.
    d. Change Orders.
    e. Request for Information/Interpretations.
    f. Applications for Payment.
    g. Record Documents.
8. Use of premises:
    a. Office, construction, and storage areas.
    b. Owner's requirements.
9. Construction facilities, controls, and construction aids.
10. Temporary utilities.
11. Safety and first aid procedures.
12. Security procedures.
13. Housekeeping procedures.

F. Engineer will record minutes of meeting and distribute copies of minutes within 7 days of meeting to participants and interested parties.

1.04 PROGRESS MEETINGS

A. Engineer will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Attendance required: Owner, Engineer, Contractor, Contractor’s Project Manager, superintendent, quality control manager, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meeting.

D. Additional invitees: Owner utility companies when the Work affects their interests, and others necessary to agenda.

E. Agenda:
1. Review minutes of previous meeting/minutes.
2. Safety and security.
3. Construction schedule summary.
4. Review of 6 weeks schedule.
5. Review of off-site fabrication and delivery schedules.
6. Review of submittals schedule and status of submittals.
7. Request for information (RFI’s) status.
8. MOP’s/shutdown coordination.
9. Change order management status.
10. Maintenance of quality standards (QA/QC).
11. Field observations, problems, and conflicts.
12. Commissioning and process start-up.
13. Partnering recognition status (optional).
14. General Items.
15. Action items.
16. Next meeting.

F. Engineer will record minutes and distribute copies within 5 calendar days after meeting to participants, with copies to Contractor, Owner, and those affected by decisions made.

1.05 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections or requested by Engineer, convene pre-installation meeting at Project site before commencing work of specific section.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Engineer no later than 7 calendar days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

E. Contractor will record minutes and distribute electronic copies within 7 calendar days after meeting to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.06 SCHEDULE UPDATE MEETINGS

A. Engineer will schedule meetings throughout progress of the Work at maximum monthly intervals.

B. Engineer will make arrangements for meetings; Contractor will prepare agenda with copies for participants, and preside at meetings.

C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, General Superintendent, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meetings.

D. Additional invitees: Owner utility companies when the Work affects their interests and others necessary to the agenda.

E. Agenda:
   1. Review Monthly Schedule, (Actual Progress and Variance).
      a. "Activities Started/Completed" this period.
      b. "Activities Started/Completed" "Variance" Baseline vs. current.
      c. "Added/Deleted Activities".
      d. "Revised Activity Descriptions".
      e. Any significant Proposed Logic Changes.
   2. Review milestone "Substantial Completion" Schedule:
      a. "Critical" Activities - "Critical Area, Float and Vital Statistics".
   3. Review "Cumulative and Monthly Costs" graph.
   4. Review "Budgeted Cost" indicating the Current Project Budgeted Cost.

F. Contractor will record changes for update and distribute electronic copies within 7 calendar days after meeting to participants and interested parties.

1.07 QUALITY CONTROL MEETINGS

A. Contractor will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Contractor will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Attendance Required: Construction Manager and staff, Contractor's Quality Control Manager and staff.

D. Agenda:
   1. Review minutes of previous meetings.
   2. Review of Work progress and schedule.
   3. Review of out-of-compliance inspection or test results.
   4. Field observations, problems, and decisions.
   5. Review of offsite fabrication and delivery schedules.
   6. Planned progress during succeeding work period.
   7. Coordination of required inspections and tests.
   8. Review 6-week schedule report with upcoming inspections and special tests.
   9. Maintenance of quality and work standards.
   10. Other business relating to Work.

E. Contractor will record minutes and distribute electronic copies within 5 calendar days after meeting to participants, and those affected by decisions made.

1.08 PRE-SHUTDOWN MEETINGS

A. Follow Owner's standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 - Work Restrictions for MOP format.

B. All short-term and longer-term shutdowns and other tie-ins that require an Owner approved MOP also require a pre-shutdown meeting at Project site prior to commencing shutdown for tie-in or modification of specific plant systems.

C. Require attendance of parties directly affecting, or affected by shutdown, including Engineer, specific work crews, Owner's construction, operations, and maintenance staff.

D. Notify Engineer no later than 7 calendar days in advance of meeting date.

E. Prepare agenda and preside at meeting:
   1. Review accepted MOP including conditions of shutdown, preparation, and installation procedures.
   2. Review timelines and sequences.
   3. Review responsibilities.
   4. Review dry run plan and schedule, as necessary.
   5. Review coordination with related work.

F. Contractor will record minutes and distribute copies within 5 calendar days after meeting and prior to scheduled shutdown to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.09 COMMISSIONING COORDINATION MEETINGS

A. All processes and equipment that requires testing and process start-up also requires a pre-startup meeting at Project site before commencing process start-up of specific plant systems.

B. Require attendance of parties directly affecting, or affected by process start-up and testing, including Engineer, Commissioning Coordinator, specific work crews, Owner's construction operations, and maintenance staff.

C. Notify Engineer no later than 7 calendar days in advance of meeting date.

D. Prepare agenda:
   1. As specified in Section 01756 - Commissioning.
   2. Review accepted Construction Method of Procedure (MOP).
   3. Owner make final decision for GO or NO GO.

E. Preside at meeting.

F. Contractor will record minutes and distribute electronic copies within 5 calendar days after meeting and prior to scheduled process start-up to participants, with copies to Engineer, Owner, and those affected by decisions made.
   1. Follow Owner's standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 - Work Restrictions for MOP format.

1.10 ELECTRICAL AND INSTRUMENTATION COORDINATION MEETINGS

A. Electrical Meetings:
   1. Pre-submittal review meeting as specified in Section 16050 - Common Work Results for Electrical.
   2. Other meetings as required and as otherwise specified.

B. Instrumentation and Control Meetings:
   1. Other meetings as required and as otherwise specified.

1.11 CLOSE-OUT MEETING

A. Engineer will schedule close-out meeting.

B. Engineer will make arrangements for meeting, prepare agenda with copies for participants, and preside at meeting.

C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, and Superintendent.

D. Agenda:
   1. Review punch list completion.
   2. Transfer of record documents.
   3. Finalize payment.

E. Engineer will record minutes and within 5 calendar days after meeting distribute copies to participants.

1.12 POST CONSTRUCTION MEETING

A. Meet with and inspect the Work 11 months after date of Substantial Completion with Owner and Engineer.

B. Owner will arrange meeting at least 7 days before meeting.

C. Meet in Owner's office or other mutually agreed upon place.

D. Inspect the Work and draft list of items to be completed or corrected.

E. Review service and maintenance contracts, and take appropriate corrective action when necessary.

F. Complete or correct defective work and extend correction period accordingly.

G. Require attendance of Contractor, Project Manager, or Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01321

SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation, submittal, and maintenance of schedules and reports.

1.02 SCHEDULER

A. Designate, in writing and within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.

B. Qualifications of scheduler:
   1. Authority to act on behalf of Contractor.
   2. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
   3. Knowledge of critical path method (CPM) scheduling utilizing Primavera P6 Professional or SureTrak or Microsoft Project software.

C. Owner reserves the right to disapprove scheduler when submitted by Contractor if not qualified.

D. Owner reserves the right to remove scheduler from the project if found to be unqualified.

1.03 SCHEDULING FORMAT AND SOFTWARE

A. Schedule format: Utilize CPM format.

B. Prepare computerized schedule utilizing Primavera P6 Professional or SureTrak or Microsoft Project software, most current version.

C. Contractor and Engineer must agree on the format.

1.04 PRECONSTRUCTION SCHEDULING MEETING

A. Engineer will conduct Preconstruction Scheduling Meeting with Contractor’s Project Manager, General Superintendent, and scheduler within 7 calendar days after Notice to Proceed.
   1. This meeting is separate from the Preconstruction Conference Meeting and is intended to exclusively cover schedule issues.

B. At the meeting, review scheduling requirements.
   1. These include schedule preparation, reporting requirements, labor and equipment loading, updates, revisions, and schedule delay analysis
   2. Present schedule methodology, planned sequence of operations, cost and resource loading methodology, and proposed activity coding structure.

3. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule.
    a. Example 1: 2014_07_30 rev 1 draft baseline schedule.xer.
    b. Example 2: 2014_09_30 rev 2 sep final update.xer.
4. Coding structure:
    a. Submit proposed coding structure, identifying the code fields and the associated code values it intends to use in the project schedule.
    b. A minimum, include code fields for Project Segment or Phase, Area of Work, Type of Work, Submittal/Procurement/Construction and Responsibility/Subcontractor. Refer to NETWORK DETAILS AND GRAPHICAL OUTPUT for listing of activity categories to be included in the schedule.

C. Filing: Post submitted files to Owner's construction document control system.

1.05 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review Baseline Schedule, Schedule Updates, Schedule Revisions and Time Impact Analyses to ascertain compliance with specified project constraints, compliance with milestone dates, reasonableness of durations and sequence, accurate interrelationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of Baseline Schedule within 21 calendar days after receipt.

C. Written comments on review of Schedule Updates and Schedule Revisions and Time Impact Analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit schedule in accordance with Engineer's comments within 7 calendar days after receipt of such comments, or request joint meeting to resolve objections.

E. If Engineer requests a meeting, the Contractor and all major subcontractors must participate in the meeting with Engineer.
    1. Revise and resubmit schedule within 7 calendar days after meeting.

F. Use accepted schedule for planning, organizing, and directing the work and for reporting progress.

G. Engineer's submittal review response:
    1. When schedule reflects Owner's and Contractor's agreement of project approach and sequence, schedule will be accepted by Owner.
    2. Engineer's submittal review response for schedule submittal will be "Receipt Acknowledged - Filed for Record" including applicable comments.
    3. Acceptance of the schedules by the Owner is for general conformance with the Contract Documents and for Owner's planning information, and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the contract completion dates. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.06 SCHEDULE UPDATES

A. Any update:
   1. Prepare update using most recent accepted version of schedule including:
      a. Actual start dates of activities that have been started.
      b. Actual finish dates of activities that have been completed.
      c. Percentage of completion of activities that have been started but not finished.
      d. Actual dates on which milestones were achieved.
      e. Update activities by inputting percent complete figures with actual dates.
      f. Use retained logic in preparing Schedule Updates.
      g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
      h. Revisions to the schedule may be included that have been previously approved as specified in this Section under Revisions to Schedule.

B. Monthly updates:
   1. Submit written narrative report in conjunction with each Schedule Update including descriptions of the following:
      a. Activities added to or deleted from the schedule are to adhere to cost and other resource loading requirements.
         1) Identify added activities in manner distinctly different from original activity designations.
      b. Changes in sequence or estimated duration of activities.
      c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
      d. Assumptions made and activities affected by incorporating change order work into the schedule.
   2. Submit updated schedule and materials specified under Submittal of Progress Schedules, 5 calendar days before the monthly schedule update meeting.
   3. Since Monthly Schedule Update is the application for progress payment required as specified in Section 01294 - Applications for Payment, submittal and acceptance of the monthly Schedule Update is a condition precedent to the making of any progress payments.

C. Weekly progress meeting:
   1. Update the schedule prior to weekly progress meeting.
      a. Identify overall progress of each Major Item of Work in the Summary Schedule.
      b. If there are significant changes to the schedule, submit a written report at the weekly progress meeting.
   2. Should monthly Schedule Update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as “Project Float”.
   3. Should monthly Schedule Update show project completion later than current Contract completion date, prepare and submit a Schedule Revision in accordance with the Revisions to Schedule.

1.07 REVISIONS TO SCHEDULE

A. Submit Revised Schedule within 5 days:
   1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
   2. When delays in submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
   3. When the schedule does not represent the actual progress of activities.
   4. When any change to the sequence of activities, the completion date for major portions of the work, or when changes occur which affect the critical path.
   5. When Contract modification necessitates schedule revision, submit schedule analysis of change order work with cost proposal.

B. Create a separate submittal for Schedule Revisions.
   1. Comply with schedule updates as specified in this Section.
   2. Do not submit with Schedule Updates.

C. Schedule Revisions will not be reflected in the schedule until after the revision is accepted by the Owner.
   1. This includes Schedule Revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.08 ADJUSTMENT OF CONTRACT TIMES

A. Contract Time will be adjusted only for causes specified in Contract Documents.
   1. Non-excusable delay:
      a. Non-excusable delays include actions or inactions of the Contractor, or events for which the Contractor has assumed contractual responsibility (including actions or inactions of subcontractors, suppliers, or material manufacturers at any tier) that would independently delay the completion of the Work beyond the current Contract completion date).
      b. No time extensions will be granted for non-excusable delays.
   2. Excusable delay:
      a. Events which are unforeseeable, outside the control of, and without the fault or negligence of either the Owner or the Contractor (or any party for whom either is responsible), which would independently delay the completion of the Work beyond the current Contract completion date.
      b. The Contractor is entitled to a time extension only.
      c. No other damages will be approved.
   3. Compensable delay:
      a. Actions or inactions of the Owner, or events for which the Owner has assumed contractual responsibility, which would independently delay the completion of the Work beyond the current Contract completion date.
      b. The Contractor is entitled to a time extension and delay damages.
   4. Concurrent delay:
      a. Concurrent delay is any combination of the above 3 types of delay occurring on the same calendar date.
      b. Exception to concurrent delay: Cases where the combination consists of 2 or more instances of the same type of delay occurring on the same calendar date. When one cause of delay is Owner-caused or caused by an event which is beyond the control and without the fault or negligence of

either the Owner or the Contractor and the other Contractor-caused, the Contractor is entitled only to a time extension and no delay damages.

B. If the Contractor believes that the Owner has impacted its work, such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path.
   1. This proof, in the form of a Time Impact Analysis, may entitle the Contractor to an adjustment of Contract Time.

C. Time Impact Analysis:
   1. Use the accepted schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the schedule by:
      a. Inserting new activities associated with the delay event into the schedule.
      b. Revising activity logic.
      c. Revising activity durations.
   2. If the project schedule's critical path and completion date are impacted as a result of adding this delay event to the schedule, a time extension equal to the magnitude of the impact may be warranted.
   3. The Time Impact Analysis submittal must include the following information:
      a. A fragment of the portion of the schedule affected by the delay event.
      b. A narrative explanation of the delay issue and how it impacted the schedule.
      c. A schedule file used to perform the Time Impact Analysis.

D. When a delay to the project as a whole can be avoided by revising preferential sequencing or logic, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the Contractor has used, in full, all project float available for the work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date.
   1. Utilize the latest version of the Schedule Update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Adjustment of the Contract Times will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date.
   1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.

G. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to jobsite or home office overhead beyond the Contractor's originally planned occupancy of the site.

I. Notify Engineer of a request for Contract Time adjustment.
   1. Submit request as specified with Contract Documents.

2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

J. The Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing.
   1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule Update.
   2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
   3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
   4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.09 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor's intention to execute the Work within specified time and constraints.
   1. Failure to conform to requirement may result in termination for cause.

B. Contractor's bid covers all costs associated with the execution of the Work in accordance with the Progress Schedule.

C. During preparation of the preliminary Progress Schedule, Engineer will facilitate Contractor's efforts by being available to answer questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare schedule utilizing Precedence Diagramming Method (PDM).

E. Prepare schedule utilizing activity durations in terms of working days.
   1. Do not exceed 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
   2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
   3. Coordinate holidays to be observed with the Owner and incorporate them into the schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract.
   1. Contract requirements are not waived by failure of Contractor to include required schedule constraints, sequences, or milestones in schedule.
   2. Contract requirements are not waived by Owner’s acceptance of the schedule. In event of conflict between accepted schedule and Contract requirements,

terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference schedule to working days with beginning of Contract Time as Day "1".

H. Baseline Schedule and Project Completion:
   1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's schedule completion date.
   2. Adjust accordingly any Contract milestone dates.

I. Imposed dates, hidden logic prohibited: Do not use imposed dates or hidden logic in preparation of schedule.

J. Interim milestone dates, operational constraints:
   1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on schedule.
   2. Do not use Zero Total Float constraint or Mandatory Finish Date on such Contract requirements.

K. Contract float is for the mutual benefit of both Owner and Contractor.
   1. Changes to the project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time, by utilizing float.
   2. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date.
   3. Likewise, Contractor may utilize float to offset delays other than delays caused by Owner.
   4. Mutual use of float can continue until all available float shown by schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.
   5. Non-sequestering of float: Pursuant to float sharing requirements of Contract, schedule submittals can be rejected for, use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations or imposed dates.

L. Resource loading and leveling: Input labor and equipment data on each schedule activity.
   1. Manpower data consist of the man-hours estimated to perform each task, categorized by trade.
   2. Equipment data consist of equipment hours estimated to perform each task, categorized by piece of equipment. Optimize and level manpower and equipment requirements.
   3. Resource leveling reflect a reasonable plan for accomplishing Work.
   4. Individual activities may be sequenced within limits of available float.
   5. Keep to a minimum critical or near critical paths resulting from use of labor or equipment restraints.
   6. Near critical path identified as path with 15 or less working days of float.

M. Schedule logic:
   1. Assembled to show order in which Contractor proposes to carry out Work, indicate restrictions of access, availability of Work areas, and availability and use of manpower, materials, and equipment.
   2. Form basis for assembly of schedule logic on the following criteria:
      a. Which activities must be completed before subsequent activities can be started?
      b. Which activities can be performed concurrently?
      c. Which activities must be started immediately following completed activities?
      d. What major facility, equipment, or manpower restrictions are required for sequencing these activities?

N. Major subcontractor, parallel prime contractor signoff:
   1. Provide written confirmation of concurrence from all major subcontractors and independent prime contractors on site with all schedule submittals.
   2. Term “major subcontractor” as used in this Section means any subcontractor, at any tier, with a subcontract worth 5 percent or more of the total cost of the Work.

O. Schedule windows for Owner-furnished, Contractor-installed equipment or materials:
   1. Immediately after Award of Contract, obtain from Engineer anticipated delivery dates of Owner furnished equipment or materials.
   2. Show these dates in the schedule in same manner indicated by Engineer.

P. Cost loading: All schedules:
   1. Only on-site construction activities.
   2. The sum total of all cost loaded activities equal to the current value of the Contract, including change orders, at all times.
   3. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01292 - Schedule of Values
   4. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01294 - Applications for Payment.
   5. Payments will not be made until updated Schedule of Values is accepted.

1.10 NETWORK DETAILS AND GRAPHICAL OUTPUT

A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram.
   1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished.
   1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.

D. Indicate the critical path for the project.

E. Delineate the specified contract duration and identify the planned completion of the Work as a milestone.
   1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as project float unless a Change Order is issued to officially change the Contract completion date.

F. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion date as milestones.

G. Include, in addition to construction activities:
   1. Submission dates and review periods for major equipment submittals, shoring submittals, and indicator pile program:
      a. Shoring reviews: Allow 4-week review period for each shoring submittal.
   2. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
   3. Equipment and long-lead material deliveries over 8 weeks.
   4. Approvals required by regulatory agencies or other third parties.

H. Produce network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

I. Identify the execution of the following:
   1. Mobilization.
   2. All required submittals and submittal review times showing 30 calendar day duration for such activities and equal amount of time for re-submittal reviews.
   3. Equipment and materials procurement/fabrication/delivery.
   4. Excavation.
   5. Shoring design and submission of detailed shoring submittals. Identify submission as a milestone.
   6. Shoring review, shoring materials procurement, shoring installation, and shoring removal.
   7. Backfill and compaction.
   8. Dewatering.
   9. Grading, subbase, base, paving, and curb and gutters.
   10. Fencing and landscaping.
   11. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
   12. Tests for leakage of concrete structures intended to hold water.
   13. Metal fastenings, framing, structures, and fabrications.
   14. Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.
   15. Finishes including coating and painting, flooring, ceiling, and wall covering.
   16. Process equipment, including identification of ordering lead-time, factory testing, and installation.
   17. Pumps and drives, including identification of ordering lead time, factory testing, and installation.
   18. Trenching, pipe laying, and trench backfill and compaction.
   19. Piping, fittings, and appurtenances, including identification of ordering and fabrication lead time, layout, installation and testing.
   20. Valves, gates, and operators, including identification of order lead-time, installation, and testing.
   21. Plumbing specialties.

22. Electric transmission, service, and distribution equipment, including identification of ordering lead-time, and factory testing.
23. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
24. Instrumentation and controls, including identification of ordering lead-time.
25. Preliminary testing of equipment, instrumentation, and controls.
26. Commissioning Phase:
    a. Source Testing.
    b. Owner Training.
    c. Installation Testing.
    d. Functional Testing.
    e. Clean Water Facility Testing.
27. Process Start-up Phase:
    a. Process Start-up.
    b. Process Operational Period.
    c. Instrumentation and Controls Performance Testing.
28. Substantial completion.
29. Punch list work.
30. Demobilization.

1.11 SUBMITTAL REQUIREMENTS

A. Submit preliminary and baseline schedule.

B. Submit, on a monthly basis, updated schedules as specified.

C. Submit final schedule update as specified.

D. Submit revised schedules and time impact analyses as specified.

E. Submit schedules in the media and number of copies as follows:
   1. Provide each submittal in PDF format and in other formats specified in this Section.
   2. 3 sets of the CPM network and/or bar chart (as specified by the Owner) on D-size sheets.
      a. Color-coding to be specified by the Owner.
   3. 3 sets of tabular reports listing all activities sorted numerically identifying duration, early start, late start, early finish, late finish, total float, and all predecessor/successor information.
   4. 2 sets of CPM Schedule data electronic files in a native backed-up file (.xer).

1.12 WEATHER DAY ALLOWANCE

A. Definition:
   1. Weather conditions that prevent or inhibit the Contractor’s performance of the Work and affect the Critical Path indicated on the Schedule shall be referred to as a Weather Day.
   2. A Weather Day is defined as the Contractor being unable to perform at least 75 percent of work on the Critical Path.

B. Allowance:
   1. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Days Allowance."

C. Actual weather day:
   1. Insert a weather delay activity in critical path to reflect actual weather day occurrences when weather days are experienced and accepted by Engineer.
   2. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of project is considered float.
   3. The Contractor shall provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and shall describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted.
      a. A schedule update will not suffice as a written notice.
      b. The Engineer will determine if the weather day constitutes a use of a portion of the Weather Day Allowance.
      c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.
      d. Weather days are considered excusable delay as defined in this Section.

1.13 PRELIMINARY SCHEDULE AND PRELIMINARY SCHEDULE OF VALUES

A. Due date:
   1. Submit proposed preliminary schedule within 14 calendar days after Notice to Proceed.
   2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule to review and make necessary adjustments.
   3. Submit revised preliminary schedule within 5 calendar days after meeting.
   4. Update Preliminary Schedule monthly during first 90 calendar days after Notice to Proceed.
      a. Use Preliminary Schedule as the payment application as specified in Section 01294 - Applications for Payment.

B. Format:
   1. Schedule of manpower and costs for all activities for first 90 calendar days of Work after receipt of Notice to Proceed.
      a. Provide realistic and level manpower and costs so as not to have unusual manpower requirements.
   2. Schedule of costs:
      a. Schedule of Values as specified in Section 01292 - Schedule of Values for first 90 calendar days of Work.
      b. Submittal and acceptance of Preliminary Schedule is condition precedent to making of progress payments as specified in Section 01294 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.
      c. Proceed with pay item Work after Preliminary Schedule and schedule of costs have been accepted by Owner.

C. Incorporate unchanged, the accepted Preliminary Schedule as first 90 calendar days of activity in Contractor’s Baseline Schedule.

1.14 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include submittals required in the Contract Documents but not limited to Commissioning Plans, Training Plans, test procedures, operation and maintenance manuals, shop drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.

B. Preliminary Schedule of Submittals:
   1. Due date: After Preliminary Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include submittals anticipated in the first 90 calendar days after Notice to Proceed using early start dates.
      b. Indicate week and month anticipated for each submittal.
      c. Indicate “Priority” submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” submittals where possible.
   3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after Notice to Proceed.

C. Final Schedule of Submittals:
   1. Due date: After Baseline Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include submittals using early start dates.
      b. Include all submittals, including those required in the Preliminary Schedule of Submittals.
      c. Indicate week and month anticipated for each submittal.
      d. Indicate “Priority” submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” submittals where possible.
   3. Submittal of Final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if schedule revisions change listing and timing of submittals.

1.15 BASELINE SCHEDULE AND BASELINE SCHEDULE OF VALUES

A. Due date: No more than 45 calendar days after Notice to Proceed.

B. Format:
   1. Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.

2. Schedule of Values.

C. Acceptance of the Baseline Schedule by the Owner is a condition precedent to making payments as specified in Section 01294 - Applications for Payment after the first 90 calendar days after Notice to Proceed.

1.16 SUMMARY SCHEDULE

A. Due date: At weekly progress meetings and after each Schedule Update or Schedule Revision.

B. Format:
   1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
   2. Intended to give an overall indication of the project schedule without a large amount of detail.

1.17 COST FLOW SUMMARY

A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Section 01294 - Applications for Payment.

B. Format:
   1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
   2. Base tabulation on the summation of the cost-loaded activities each month.
   3. Show planned amounts.
   4. Show actual earned amounts and anticipated remaining earnings.
   5. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

1.18 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

A. Due date: Submit on a monthly basis as specified in Section 01294 - Applications for Payment.

B. Format: Schedule of Values: As specified in Section 01292 - Schedule of Values.

1.19 WEEKLY SCHEDULE

A. Due date: At every weekly progress meeting.

B. Format:
   1. Contractor and Engineer must agree on the format.
   2. 6-Week Schedule showing the activities completed during the previous week and the Contractor’s schedule of activities for following 5 weeks.
   3. Use the logic and conform to the status of the current progress schedule when producing a Weekly Schedule in CPM schedule or a bar chart format.
      a. In the event that the Weekly Schedule no longer conforms to the current schedule, Contractor may be required to revise the schedule as specified in this Section.
   4. The activity designations used in the Weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule Updates.

1.20 MANPOWER SCHEDULE

A. Due date: With progress payments after Baseline Schedule has been submitted and accepted by Owner.

B. Format:
   1. Schedule histogram depicting total craft manpower and craft manpower for Contractor's own labor forces and those of each subcontractor.
   2. Submit electronically on a computer disk in Excel format, with 1 paper copy.

C. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until manpower schedule is provided.

D. Due date: After Baseline Schedule has been submitted and accepted by Owner.

E. Format:
   1. Tabular report listing each major piece of construction equipment to be used in performing the Work.
   2. Include major equipment for Contractor and each subcontractor.
   3. Submit electronically on a computer disk in Excel format with 1 paper copy.

F. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until equipment schedule is provided.

1.21 COMMISSIONING SCHEDULE

A. Proposed Commissioning Schedule:
   1. Due date: As specified in Section 01756 - Commissioning.
   2. Schedule requirements: As specified in Section 01756 - Commissioning.
   3. Engineer response due within 20 calendar days of receipt.
   4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.

B. The Commissioning Schedule may not be combined with the Detailed Schedule until Engineer acceptance of the Proposed Commissioning and Process Start-up Schedule.

C. Commissioning Schedule monthly update requirements:
   1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.
   2. Include activities not previously included in the previously accepted detail work plan Commissioning Schedule.
   3. Change Order required for any change to contractual dates.
   4. Reviews of these submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

1.22 FINAL SCHEDULE

A. The final Schedule Update becomes the As-Built Schedule.
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.

2. Contractor's Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule Update is provided.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01322

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for web-based construction document management.

1.02 REQUIREMENTS

A. Owner, Engineer, and Contractor shall utilize EADOC (EADOC is a registered trademark of EADOC LLC). For submission of all data and documents (unless specified otherwise in this Section) throughout the duration of the Contract.
   1. EADOC is a web-based electronic media site hosted by EADOC LLC.
   2. EADOC is available to all Contractor's personnel, subcontractor personnel, suppliers, consultants, Owner, and Engineer at no cost.
   3. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
   4. EADOC shall be the primary means of project information submission and management.

1.03 USER ACCESS LIMITATIONS

A. Provide a list of Contractor's key EADOC personnel for the Engineer's acceptance. The Engineer reserves the right to perform a security check on all potential users. The Contractor will be allowed to add additional personnel and subcontractors to EADOC.

B. The Engineer will grant initial access to EADOC by creating user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function-based authorizations and user privileges. Subcontractors and suppliers will be given access to EADOC by and through the Contractor. Contractor is responsible for adding and removing users from the system after the initial setup by the Engineer.

1.04 JOINT OWNERSHIP OF DATA

A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EADOC system) by Engineer and Contractor will be jointly owned.

1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents.

Owner’s acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.06 COMPUTER REQUIREMENTS

A. Contractor shall use computer hardware and software that meets the requirements of the EADOC system as recommended by EADOC LLC to access and utilize EADOC. As recommendations are modified by EADOC, Contractor will upgrade their system(s) to meet or exceed the recommendations. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.

B. Contractor shall ensure that connectivity to the EADOC system is accomplished through DSL, cable, T-1 or wireless communications systems. The minimum bandwidth requirements for using the system is 128 kb/s. It is recommended a faster connection be used when uploading pictures and files into the system.

C. EADOC supports the current and prior 2 major versions of Chrome, Mozilla's Firefox, Microsoft’s Internet Explorer and Apple’s Safari on a rolling basis.
   1. Each time a new version of one of these browsers is released, EADOC will begin supporting the update and stop supporting the fourth-oldest version.

1.07 CONTRACTOR RESPONSIBILITY

A. Contractor shall be responsible for the validity of their information placed in EADOC and for the abilities of their personnel.

B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on EADOC shall be the responsibility of the Contractor.

C. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program.

D. Contractor shall utilize the existing forms in EADOC to the maximum extent possible. If a form does not exist in EADOC the Contractor must include a form of their own or provided by Engineer as an attachment to a submittal.

E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of EADOC (outside what is provided by Owner) and the other programs indicated above as needed.

1.08 TRAINING

A. The Owner has arranged and paid for web-based training on EADOC for the Contractor.

B. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate Contractor’s training.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. EADOC project management application (no equal). Provided by EADOC LLC, www.EADOCsoftware.com.

PART 3 EXECUTION

3.01 EADOC UTILIZATION

A. EADOC shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

A. Use EADOC for submittals.

B. Content: As specified in Section 01330 - Submittal Procedures.

C. Format: As specified in Section 01330 - Submittal Procedures.

D. Submit Portable Document Format (PDF) documents to the EADOC submittal workflow process and forms.
   1. Consolidate electronic format submittals with multiples pages into a single file.

E. Hardcopy submittals:
   1. Contractor shall provide 2 hard copies of submittals within 14 days of the Submittal being closed.
   2. Hardcopy requirements as specified in Section 01330 - Submittal Procedures.

F. Samples:
   1. Contractor shall enter submittal data information into EADOC.
   2. Attach a copy of the submittal form(s) to the sample.

G. Record and Closeout Submittals:
   1. Operation and maintenance data as specified in Section 01782 - Operation and Maintenance Data.
   2. Extra materials, spare parts, etc.

3.03 REQUESTS FOR INFORMATION/INTERPRETATION (RFI)

A. Use EADOC for RFIs as specified in Section 01260 - Contract Modification Procedures.

3.04 OFFICIAL CORRESPONDENCE

A. Use EADOC for memos, notices, change proposals, or any official correspondence.

3.05 INSPECTION REQUESTS

A. Use EADOC to request inspection for a portion of Work that is ready for inspection and prior to covering up the Work.

3.06 FINANCIAL SUBMITTALS

A. Use EADOC for financial submittals as specified in Section 01330 - Submittal Procedures.

3.07 OTHER

A. Use EADOC for daily reports, meeting agendas and minutes, and other construction documents.

END OF SECTION

SECTION 01329

SAFETY PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Development and maintenance of a Construction Safety Plan.

1.02 REFERENCES

A. 29 CFR 1926, Subpart C in Utah.

B. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

C. Occupational Safety and Health Administration (OSHA).

1.03 CONSTRUCTION SAFETY PLAN

A. Detail the Methods and Procedures to comply with 29 CFR 1926 Subpart C in Utah, NFPA 70E, Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Methods and procedures must also comply with the Owner's Safety Plan. Include the following:
   1. Identification of the Certified or Licensed Safety Consultant who will prepare, initiate, maintain and supervise safety programs, and procedures.
   2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
   3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, safety equipment used in multi-level structures, personal protective equipment (PPE) as required by NFPA 70E.
   4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
   5. Procedures for reporting safety or health hazards.
   6. Procedures to follow to correct a recognized safety and health hazard.
   7. Procedures for investigation of accidents, injuries, illnesses, and unusual events that have occurred at the construction site.
   8. Periodic and scheduled inspections of general work areas and specific workstations.
   9. Training for employees and workers at the jobsite.
   10. Methods of communication of safe working conditions, work practices and required personal protection equipment.
   11. Provision of a site-specific emergency action and evaluation plan.
   12. Verify safety plan includes reference to and compliance with latest Owner safety policies.

B. Assume sole responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
   1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
   2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.

C. Transmit to Owner and Engineer copies of reports and other documents related to accidents or injuries encountered during construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements and procedures for submittals.

1.02 REFERENCES

A. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Certificates: Describe certificates that document affirmations by the Contractor or other entity that the work is in accordance with the Contract Documents.

B. Extra stock materials: Describe extra stock materials to be provided for the Owner's use in facility operation and maintenance.

C. Maintenance material submittals: Use this article to categorize maintenance materials submittals requiring no Engineer action other than confirmation of receipt under an explanatory heading.

D. Manufacturer's instructions: Instructions, stipulations, directions, and recommendations issued in printed form by the manufacturer of a product addressing handling, installation, erection, and application of the product; manufacturer's instructions are not prepared especially for the Work.

E. Product data: Product data usually consists of manufacturers' printed data sheets or catalog pages illustrating the products to be incorporated into the project.

F. Samples: Samples are full-size actual products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.

G. Spare parts: Describe spare parts necessary for the Owner's use in facility operation and maintenance; identify the type and quantity here, but include the actual characteristics of the spare parts in Product as part of the specification of the product.

H. Submittals: Submittals are samples, product data, shop drawings, and others that demonstrate how Contractor intends to conform with the Contract Documents.

I. Tools: Tools are generally defined as items such as special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit.

1.04 GENERAL INSTRUCTIONS

A. Certification: Contractor is responsible to determine and verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved shop drawings and all Contract requirements.

B. Provide submittals that are specified or reasonably required for construction, operation, and maintenance of the Work.

C. Where multiple submittals are required, provide a separate submittal for each specification section.
   1. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
      a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section.
      b. For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.

D. Edit submittals so that the submittal specifically applies to only the equipment furnished.

E. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.

F. Prepare submittals in the English language. Do not include information in other languages.

G. Present measurements in customary American units (feet, inches, pounds, etc.).

H. Must be clear and legible, and of sufficient size for presentation of information.

I. Minimum page size will be 8 1/2 inches by 11 inches:
   1. Maximum page size will be 11 inches by 17 inches.

J. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.

K. Provide submittal information from only 1 manufacturer for a specified product. Submittals with multiple manufacturers for 1 product will be rejected without review.

L. Indicate project designated equipment tag numbers from P&IDs for submittal of devices, equipment, and assemblies.

1.05 SUBMITTAL ORGANIZATION

A. Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.

B. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is used.

C. Bookmarks:
   1. Bookmarks shall match the table of contents.
   2. Bookmark each section (tab) and heading.
   3. Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
   4. At file opening, display all levels of bookmarks as expanded.

D. Thumbnails optimized for fast web viewing.

E. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.

F. Attachments:
   1. Specification section: Include with each submittal a copy of the relevant specification section.
      a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   2. Drawings: Include with each submittal a copy of the relevant Drawing, including relevant addendum updates.
      a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
      c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

G. Contractor: Prepare submittal information in sufficient detail to show compliance with specified requirements.
   1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
   2. Coordinate submittal with other submittals and with the requirements of the Contract Documents.
   3. Check, verify, and revise submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

1.06 SUBMITTAL METHOD AND FORMAT

A. As specified in Section 01322 - Web Based Construction Document Management.

B. Submittal identification numbering:
   1. Number each submittal using the format defined below:

	Spec Section Number	**Dash**	**Initial Submittal - Sequential Number**	**Decimal Point**	**Subsequent Submittal Revisions Sequential Number**
Example 1 Description	Cast-In-Place Concrete		8th initial submittal		
	03300	-	0008		
Example 2 Description	Cast-In-Place Concrete		8th initial submittal		First revision to the 8th initial submittal
	03300	-	0008	.	1

C. Submittals in electronic media format:
   1. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.
   2. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).
   3. Graphics: Provide graphic submittals (drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).
   4. Contractor using other software shall be required to provide to the Engineer conclusive evidence of 100-percent data transfer compatibility.

1.07 SUBMITTAL PROCEDURE

A. Engineer: Review submittal and provide response:
   1. Review description:
      a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
      b. Engineer's review of submittals shall not release Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall Engineer's review release Contractor from fulfilling purpose of installation nor from Contractor's liability to replace defective work.
      c. Engineer's review of shop drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
      d. Engineer's review does not extend to:
         1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by Contractor.
         2) Contractor's means, methods, techniques, sequences, or procedures except when specified, indicated on the Drawings, or required by Contract Documents.
         3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.

e. Engineer can Approve or Not Approve any exception at their sole discretion.

2. Review timeframe:
   a. Except as may be provided in technical specifications, a submittal will be returned within 30 days.
   b. When a submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the submittal, give notice of the date by which that submittal will be returned.
   c. Engineer's acceptance of progress schedule containing submittal review times less than those specified or agreed to in writing by Engineer will not constitute Engineer's acceptance of review times.
   d. Critical submittals:
      1) Contractor will notify Engineer in writing that timely review of a submittal is critical to the progress of Work.
3. Schedule delays:
   a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of submittals, unless all of the following criteria are met:
      1) Engineer has failed to review and return first submission within the agreed upon time frame.
      2) Contractor demonstrates that delay in progress of Work is directly attributable to Engineer's failure to return submittal within time indicated and accepted by Engineer.
4. Review response will be returned to Contractor with one of the following dispositions:
   a. Approved:
      1) No Exceptions:
         a) There are no notations or comments on the submittal and the Contractor may release the equipment for production.
      2) Make Corrections Noted - See Comments:
         a) The Contractor may proceed with the work; however, all notations and comments must be incorporated into the final product.
         b) Resubmittal not required.
      3) Make Corrections Noted - Confirm:
         a) The Contractor may proceed with the work; however, all notations and comments must be incorporated into the final product.
         b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
   b. Not approved:
      1) Correct and resubmit:
         a) Contractor may not proceed with the work described in the submittal.
         b) Contractor assumes responsibility for proceeding without approval.
         c) Resubmittal of complete submittal package is required within 30 calendar days of the date of the Engineer's submittal review response.
      2) Rejected - See Remarks:
         a) Contractor may not proceed with the work described in the submittal.

b) The submittal does not meet the intent of the Contract Documents. Resubmittal of complete submittal package is required with materials, equipment, methods, etc. that meet the requirements of the Contract Documents.

c. Receipt acknowledged - Filed for record:
   1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.

d. Receipt acknowledged with comments - Resubmit:
   1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.

B. Contractor: Prepare resubmittal, if applicable:
   1. Clearly identify each correction or change made.
   2. Include a response in writing to each of the Engineer's comments or questions for submittal packages that are resubmitted in the order that the comments or questions were presented throughout the submittal and numbered consistent with the Engineer's numbering.
      a. Acceptable responses to Engineer's comments are listed below:
         1) "Incorporated" Engineer's comment or change is accepted, and appropriate changes are made.
         2) "Response" Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
      b. Reviews and resubmittals:
         1) Contractor shall provide resubmittals which include responses to all submittal review comments separately and at a level of detail commensurate with each comment.
         2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment. Responses such as "acknowledged" or "noted" are not acceptable.
         3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
         4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant submittals.
         5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.
      c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for Revision and Resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.
   3. Resubmittal timeframe:
      a. Contractor shall provide resubmittal within 15 days.
      b. When a resubmittal cannot be returned within the specified period, Contractor shall notify Engineer in writing.

4. Review costs:
    a. Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
    b. Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

1.08 SHOP DRAWINGS

A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of shop drawings.

B. Details:
1. Fabrication drawings: Drawn to scale and dimensioned.
2. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
3. Locations of conduit entrances and access plates.
4. Component layout and identification.
5. Weight.
6. Finish.
7. Temperature limitations, as applicable.
8. Nameplate information.

C. Minor or incidental products and equipment schedules:
1. Details:
    a. Shop Drawings of minor or incidental fabricated products will not be required, unless requested.
    b. Submit tabulated lists of minor or incidental products showing the names of the manufacturers and catalog numbers, with Product Data and Samples as required to determine acceptability.

1.09 PRODUCT DATA

A. Details:
1. Supplier name and address.
2. Subcontractor name and address.

B. Include:
1. Catalog cuts.
2. Bulletins.
3. Brochures.
4. Manufacturer’s Certificate of Compliance: Signed by product manufacturer along with supporting reference data, affidavits, and tests, as appropriate.
5. Manufacturer’s printed recommendations for installation of equipment.
6. Quality photocopies of applicable pages from manufacturer’s documents.

C. Motor Data Sheet:
1. Provide completed Motor Data Sheet as specified in Section 16222 - Low Voltage Motors Up to 500 Horsepower, for every motor furnished as part of the associated equipment submittal.

D. Test reports including the following information:
1. Test description.

2. List of equipment used.
3. Name of the person conducting the test.
4. Date and time the test was conducted.
5. Ambient temperature and weather conditions.
6. All raw data collected.
7. Calculated results.
8. Clear statement if the test passed or failed the requirements stated in Contract Documents.
9. Signature of the person responsible for the test.

E. Certificates:
1. As specified in technical sections.
2. For products that will be in contact with potable water, submit evidence from a nationally recognized laboratory that the products comply with the requirements of the NSF 61 standard.

1.10 SAMPLES

A. Details:
1. Submit labeled samples.
2. Samples will not be returned.
3. Provide samples from manufacturer's standard colors, materials, products, or equipment lines.
   a. Clearly label samples to indicate any that represent non-standard colors, materials, products, or equipment lines and that if selected, will require an increase in Contract Time or Contract Price.
4. Provide number of sample submittals as below:
   a. Total: 2 minimum.
      1) Owner: 1.
      2) Engineer: 1.
      3) Contractor: None.

B. Field samples:
1. As specified in technical sections.

1.11 DESIGN CALCULATIONS

A. Defined in technical sections:
1. Calculations must bear the original seal and signature of a Professional Engineer licensed in the state where the project is located and who provided responsible charge for the design.

1.12 SCHEDULES

A. Progress schedules: As specified in Section 01321 - Schedules and Reports.
1. Each schedule submittal specified in these Contract Documents shall be submitted as a native backed-up file (.xer) of the scheduling program as specified in Section 01321 - Schedules and Reports.
2. The schedule and all required reports shall also be submitted as a PDF file.
3. Schedule of values: As specified in Section 01292 - Schedule of Values.
4. Schedule of submittals: As specified in Section 01321 - Schedules and Reports.

A. Progress reports and quantity charts:
   1. As specified in Section 01321 - Schedules and Reports.

1.13 REQUESTS FOR SUBSTITUTIONS (RFS)

A. As specified in Section 01600 - Product Requirements.

1.14 REQUESTS FOR INFORMATION (RFI)

A. As specified in Section 01260 - Contract Modification Procedures.

1.15 CONTRACTOR'S PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. Submit a completed Contractor's P.E. Certification Form, provided in this Section, to comply with technical sections requirement for a professional engineer's certification from an engineer licensed in the state the project is located.

1.16 CLOSEOUT SUBMITTALS

A. Provide closeout submittals as specified in Section 01770 - Closeout Procedures.

B. Operation and Maintenance Manuals: final documents shall be submitted as specified in Section 01782 - Operation and Maintenance Data.

C. Extra materials, spare parts, etc.: Submittal forms shall indicate when actual materials are submitted.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A

CONTRACTOR'S P.E. CERTIFICATION FORM

DOCUMENT 01330
CONTRACTOR'S P.E. CERTIFICATION FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY.
Contractor:	Click here to enter text.	**Registration State:**	Click here to enter text.
Project Name:	Click here to enter text.	**Project No.:**	00000.00
Responsibilities:	Click here to enter text.		
Spec Section:	Click here to enter text.		

Statement of Certification

The undersigned hereby certifies that he/she is a professional engineer registered in the State of and that he/she has been employed by

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state, and federal codes, rules, and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculation and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to:

Click here to enter text.

(Name of Owner, or Owner's representative within 7 days of receiving a written request by the Owner.)

Prof. Engineer Signature: _____ **Date:** _____

Printed Name: _____ **Company Name:** _____

Contractor's Signature: _____ **Date:** _____

Printed Name: _____

APPENDIX B

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

DOCUMENT 01330
CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY
Contractor:	Click here to enter text.	**Project No.:**	XXXXX.XX
Project Name:	Click here to enter text.	**Submittal Number:**	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal / Equipment Supplier			
Spec ##:	Spec ##.	**Subject:**	Click here to enter text.
Authored By:	Click here to enter text.	**Date Submitted:**	XX/XX/XXXX

Submittal Certification

Check Either (A) or (B):

☐ (A) We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings with no exceptions.

☐ (B) We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings except for the deviations listed.

Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.

General Contractor's Reviewer's Signature:

Printed Name:

In the event, Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.

Firm: Click here to enter text. **Signature:** **Date Returned:** XX/XX/XXXX

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

SECTION 01353

SPECIAL PROCEDURES FOR LOCATING AND VERIFYING CONCEALED EXISTING UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Special procedures for locating and verifying concealed existing utilities.

1.02 CONCEALED EXISTING UTILITIES

A. Verify locations of utilities which may exist by consulting with the Owner, utility companies, and Blue Stake or other service available in area of Project:
   1. Abide by easement and right-of-way restrictions.

B. Perform exploratory vacuum excavation potholing, as necessary to more accurately identify location, depth, configuration, and utility service in congested utility areas prior to preparation of shop drawings and subsequent excavation.
   1. Potholing shall be backfilled immediately after purpose has been satisfied and the surface restored and maintained in a manner satisfactory to Engineer.
   2. Adjustments in construction methods shall be made to accommodate utility location information gained from potholing as necessary to protect existing utilities and maintain plant in operations.
   3. Note that installation of all underground yard piping and utilities in this project are considered to be installed in congested utility areas.
   4. Some variation from the conditions indicated on the Drawings is to be expected.

C. Notify the Owner, owners of facilities when the Work will be in progress.

D. Make arrangements for potential emergency repairs in accordance with requirements of owners of utility facilities, including individual or residential facilities.

E. Assume responsibility for repair of utilities and facilities damaged by performance of the Work.

F. Expose sanitary and storm sewers, water, gas, electric, telephone utility lines, and other underground facilities indicated to permit survey location prior to commencement of Work in affected area:
   1. Expose in ample time to permit relocation of interfering utilities with minimum delaying effect on Contract Time.

G. Work required for raising, lowering, or relocating utilities not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities:
   1. When part of the Work, perform work in accordance with standards of affected utility owner, and adjustment to Contract Price and Contract Times will be made as stipulated in conditions of Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Regulatory authorities and codes.

1.02 APPLICABLE CODES

A. International Code Council (ICC).
   1. Building code:
      a. International Building Code (IBC), 2018.
      b. International Existing Building Code (IEBC), 2018.
   2. Electrical code:
      a. National Fire Protection Association (NFPA), NFPA 70: National Electrical Code (NEC), 2018.
   3. Energy code:
      a. International Energy Conservation Code (IECC), 2018.
   4. Fire code:
      a. International Fire Code (IFC), 2018.
   5. Fuel gas code:
      a. International Fuel Gas Code (IFGC), 2018.
   6. Mechanical code:
      a. International Mechanical Code (IMC), 2018.
   7. Plumbing code:
      a. International Plumbing Code (IPC), 2018.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01424

ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Abbreviations and meanings.

1.02 INTERPRETATIONS

A. Interpret abbreviations by context in which abbreviations are used.

1.03 ABBREVIATIONS

A. Abbreviations used to identify reference standards:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ABC	Associated Air Balance Council
AATCC	American Association of Textile Chemists and Colorists.
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
ABPA	Acoustical and Board Products Association
ACGIH	American Conference of Government Industrial Hygienists
ACI	American Concrete Institute
ACIL	American Council of Independent Laboratories
ADC	Air Diffusion Council
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers' Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AI	Asphalt Institute
AIA	American Institute of Architects
AIMA	Acoustical and Insulating Materials Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association International, Inc.
AMG	Arizona Masonry Guild
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWSC	American Welding Society Code
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America
BSI	Building Stone Institute
CFR	United States Code of Federal Regulations
CLFMI	Chain Link Fence Manufacturers Institute
CPSC	U.S. Consumer Product Safety Commission
CRA	California Redwood Association
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
CSA	CSA International
CSI	Construction Specifications Institute
CTI	Ceramic Tile Institute
DHI	Door and Hardware Institute
EIFS	Exterior Insulation and Finish System
EJCDC	Engineers Joint Contract Documents Committee
EPA	United States Environment Protection Agency
FDA	Food and Drug Administration
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	FM (Factory Mutual) Global
FS	Federal Specifications
FTI	Facing Tile Institute
GA	Gypsum Association
HI	Hydraulic Institute
HMMA	Hollow Metal Manufacturers Association
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineer’s Association
ICRI	International Concrete Repair Institute
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

ISA	International Society of Automation
ISO	International Organization for Standardization
JIC	Joint Industrial Council
MAG	Maricopa Association of Governments
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International
NAPA	National Asphalt Pavement Association
NAVFAC	Department of the Navy Facilities Engineering Command
NBHA	National Builders Hardware Association
NCMA	National Concrete Masonry Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NETA	InterNational Electrical Testing Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMWIA	National Mineral Wool Insulation Association
NPCA	National Paint and Coatings Association
NRCA	National Roofing Contractors Association
NSF	NSF International
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturer's Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDCA	Paint and Decorating Contractors of America
PDI	Plumbing and Drainage Institute
PEI	Porcelain Enamel Institute
PS	Product Standard
RCSC	Research Council on Structural Connections
RILEM	International Union of Testing and Research Laboratories for Materials and Structures
RTI	Resilient Tile Institute
SAE	SAE International
SCPA	Structural Clay Products Association
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association

SSPC	Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
TCA	Tile Council of America
UL	Underwriters Laboratories, Inc.
UNS	Unified Numbering System
USDA	United States Department of Agriculture
USACE	U.S. Army Corps of Engineers
USEPA	U.S, Environmental Protection Agency
VA	Vermiculite Association
WCLA	West Coast Lumberman's Association
WCLIB	West Coast Lumber Inspection Bureau
WPA	Western Pine Association
WPOA	Western Plumbing Officials Association
WRC	Welding Research Council
WSCPA	Western States Clay Products Association
WWPA	Western Wood Products Association

B. Abbreviations used in Specifications and Drawings:

a	year or years (metric unit)
A	ampere or amperes
am	ante meridian (before noon)
ac	alternating current
ac-ft	acre-foot or acre-feet
atm	atmosphere
AWG	American Wire Gauge
bbl	barrel or barrels
bd	board
bhp	brake horsepower
BIL	basic impulse insulation level
bil gal	billion gallons
BOD	biochemical oxygen demand
Btu	British thermal unit or units
Btuh	British thermal units per hour
bu	bushel or bushels
BV	bed volume(s)
C	degrees Celsius
cal	calorie or calories
cap	capita
cd	candela or candelas
cfm	cubic feet per minute
Ci	curie or curies
CIPP	Cured-in-Place Pipe
cm	centimeter or centimeters
cmu	concrete masonry unit

CO	carbon monoxide
Co.	Company
CO_2	carbon dioxide
COD	chemical oxygen demand
Corp.	Corporation
counts/min	counts per minute
cu	cubic
cu cm	cubic centimeter or centimeters
cu ft	cubic foot or feet
cu ft/day	cubic feet per day
cu ft/hr	cubic feet per hour
cu ft/min	cubic feet per minute
cu ft/sec	cubic feet per second
cu in	cubic inch or inches
cu m	cubic meter or meters
cu yd	cubic yard or yards
d	day (metric units)
day	day (English units)
db	decibels
D/d	column diameter to particle diameter ratio
DB	dry bulb (temperature)
dc	direct current
diam	diameter
DO	dissolved oxygen
DS	dissolved solids
EBCT	empty bed contact time
EER	energy efficiency ratio
emf	electromotive force
fpm	feet per minute
F	degrees Fahrenheit
ft	feet or foot
fc	foot-candle or foot candles
ft/day	feet per day
ft/hr	feet per hour
ft/min	feet per minute
ft/sec	feet per second
g	gram or grams
G	gravitational force
gal	gallon or gallons
gal/day	gallons per day
gal/min	gallons per minutes
gal/sec	gallons per second
gfd	gallons per square foot per day
g/L	grams per liter
gpd	gallons per day
gpd/ac	gallons per day per acre
gpd/cap	gallons per day per capita
gpd/sq ft	gallons per day per square foot

gph	gallons per hour
gpm	gallons per minute
gpm/sq ft	gallons per minute per square foot
gps	gallons per second
g/cm^3	grams per cubic centimeter
h	hour or hours (metric units)
ha	hectare or hectares
hp	high point
hp	horsepower
hp-hr	horsepower-hour or horsepower-hours
hr	hour or hours (English units)
Hz	hertz
ID	inside diameter
ihp	indicated horsepower
Inc.	Incorporated
inch	inch
inches	inches
inches/sec	inches per second
I/O	input/output
J	joule or joules
JTU	Jackson turbidity unit or units
k	kips
K	kelvin
K	thermal conductivity
kA	kiloampere
kcal	kilocalorie or kilocalories
kcmil	thousand circular mils
kg	kilogram or kilograms
kip	kilopound or kilopounds
km	kilometer or kilometers
kN	kilonewton or kilonewtons
kPa	kilopascal or kilopascals
ksi	kips per square inch
kV	kilovolt or kilovolts
kVA	kilovolt-ampere or kilovolt-amperes
kW	kilowatt or kilowatts
kWh	kilowatt hour
L	liter or liters
lb/1000 cu ft	pounds per thousand cubic foot
lb/acre-ft	pounds per acre-foot
lb/ac	pounds per acre
lb/cu ft	pounds per cubic foot
lb/day/cu ft	pounds per day per cubic foot
lb/day/acre	pounds per day per acre
lb/sq ft	pounds per square foot
L/D Ratio	Ratio of filter height to filter media particle diameter
lin	linear, lineal

lin ft	linear foot or feet
lm	lumen or lumens
lmh	liters per square meter per hour
log	logarithm (common)
ln	logarithm (natural)
lx	lux
m	meter or meters
M	molar (concentration)
mA	milliampere or milliamperes
max	maximum
mCi	millicurie or millicuries
meq	milliequivalent
meq/mL	milliequivalents per milliliter
MFBM	thousand feet board measure
mfr	manufacturer
mg	milligram or milligrams
mgd/ac	million gallons per day per acre
mgd	million gallons per day
mg/L	milligrams per liter
mrem	millirem
µF	microfarad or microfarads
Mil	0.001 inch (used for coating thickness)
mile	mile
mil. gal	million gallons
miles	miles
min	minimum
min	minute or minutes
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter or millimeters
mol wt	molecular weight
mol	mole
Mpa	megapascal or megapascals
mph	miles per hour
MPN	most probable number
MPT	National Pipe Thread, male fitting
mR	milliroentgen or milliroentgens
Mrad	megarad or megarads
mV	millivolt or millivolts
MW	megawatt or megawatts
µg/L	micrograms per liter
µm	micrometer or micrometers
µS/cm	microSeimens per centimeter
N	newton or newtons
N	normal (concentration)
ND	not detected
nm	nanometer
No.	number
Nos	numbers
NPT	National Pipe Thread

NRC	noise reduction coefficient
NTU or ntu	nephelometric turbidity unit
oc	on center
OD	outside diameter
ORP	oxidation-reduction potential
OT	ortho-tolidine
OTA	ortha-tolidine-arsenite
oz	ounce or ounces
oz/sq ft	ounces per square foot
Pa	pascal or pascals
pl	plate or property line
pm	post meridiem (afternoon)
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
pr	pair
psf/hr	pounds per square foot per hour
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PVC	polyvinyl chloride
qt	quart or quarts
R	radius
R	roentgen or roentgens
rad	radiation absorbed dose
RH	relative humidity
rpm	revolutions per minute
rps	revolutions per second
s	second (metric units)
S	Siemens (mho)
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
SDI	sludge density index or silt density index
sec	second (English units)
SI	International System of Units
sp	static pressure
sp gr	specific gravity
sp ht	specific heat
sq	square
cm^2 or sq cm	square centimeter or centimeters
sq ft	square feet or foot
sq inch	square inch
sq inches	square inches
km^2 or sq km	square kilometer or kilometers
m^2 or sq m	square meter or meters
mm^2 or sq mm	square millimeter or millimeters

sq yd	square yard or yards
SS	suspended solids
STC	Sound Transmission Class
SVI	sludge volume index
TDS	total dissolved solids
TEFC	totally enclosed, fan-cooled
TKN	total Kjeldahl nitrogen
TLM	median tolerance limit
TOC	total organic carbon
TOD	total oxygen demand
TOW	top of weir
TS	total solids
TSS	total suspended solids
TVS	total volatile solids
U	U Factor/U Value
U	Coefficient of Heat Transfer
U	heat transfer coefficient
UNS	Uniform Numbering System
US	United States
V	volt or volts
VA	volt-ampere or volt-amperes
W	watt or watts
WB	wet bulb
wg	water gauge
wk	week or weeks
WRT	water remediation technologies
wt	weight
yd	yard or yards
yr	year or years (English unit)

C. Abbreviations used on Drawings: As listed on Drawings or in Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Quality control and control of installation.
   2. Tolerances.
   3. References.
   4. Mock-up requirements.
   5. Authority and duties of Owner's representative or inspector.
   6. Sampling and testing.
   7. Testing and inspection services.
   8. Contractor's responsibilities.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. When specified, products will be tested and inspected either at point of origin or at Work site:
   1. Notify Construction Manager in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

B. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

C. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

D. Obtain copies of standards where required by product specification sections.

E. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.05 PRODUCT REQUIREMENTS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.06 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.07 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner’s Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor’s attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor’s means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor’s safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor’s employees or others.

E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.08 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.

4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.09 TESTING AND INSPECTION SERVICES

A. Contractor shall employ and pay for specified services of an independent quality control firm to perform Contractor quality control testing as required in the technical specifications for various work and materials. If Contractor's independent quality control testing firm is not properly certified to perform specialty inspections required by the local building department, Contractor shall employ and pay for a certified quality control specialty inspection firm to perform required testing and inspection.

B. Construction Manager may employ and pay for specified services of an "Owner's quality assurance testing firm" to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01455 - Special Tests and Inspections to confirm Contractor's compliance with Contract Documents.

C. The Contractor's independent quality control testing firm will perform tests, inspections and other services specified in individual specification sections.

D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
   3. Meets requirements of ASTM E329.
   4. Laboratory Staff: Maintain full time specialist on staff to review services.
   5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards (NBS) or accepted values of natural physical constants.
   6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NBS during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by individual specification sections.

F. Reports shall be submitted by Contractor's independent testing firm to Construction Manager, Contractor, and Owner using an electronic Web-Based Document Management system as described in specification section 01322 - Web-Based Construction Document Management, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents. Each report shall include:
   1. Date issued.
   2. Project title and number.
   3. Testing laboratory name, address, and telephone number.
   4. Name and signature of laboratory inspector.
   5. Date and time of sampling or inspection.
   6. Record of temperature and weather conditions.
   7. Date of test.
   8. Identification of product and specification section.

9. Location of sample or test in Project.
10. Type of inspection or test.
11. Results of tests and compliance with Contract Documents.
12. Interpretation of test results, when requested by Engineer.

G. Contractor shall cooperate with Owner's quality assurance testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
   2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.

H. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency or laboratory may not approve or accept any portion of the Work.
   3. Agency or laboratory may not assume duties of Contractor.
   4. Agency or laboratory has no authority to stop the Work.

I. Testing performed by Owner's quality assurance testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

J. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Contractor's independent quality control testing firm until tests demonstrate compliance with specification requirements. Payment for re-testing or re-inspection of failed tests performed by Owner's quality assurance testing firm will be charged to Contractor by deducting testing charges from Contract Sum/Price.

K. The Contractor's independent quality control testing firm responsibilities include:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Construction Manager and Contractor in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Construction Manager and Contractor of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Engineer.
   7. Attend preconstruction meetings and progress meetings.

L. Contractors independent quality control testing firm individual test reports: After each test, Contractors independent quality control testing firm will promptly submit the report electronically to Construction Manager and to Contractor. Include the following:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.

4. Date and time of sampling or inspection.
5. Identification of product and specifications section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Certified test results stamped and signed by a registered Engineer in the State of Utah.
10. Summary of conformance with Contract Documents.
11. When requested by Construction Manager, the Contractor's independent quality control testing firm will provide interpretation of test results.

M. Contractor's independent quality control testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
1. Results of testing.
2. Testing logs.
3. Outstanding deficiencies.
4. Various statistical data.
5. Testing curves (up to 4 types) as required by the Engineer.

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Provide and coordinate all quality control testing and special inspections as indicated in the specifications.

B. Cooperate with Owner's quality assurance testing firm or laboratory personnel and provide access to construction and manufacturing operations.

C. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

D. Provide to Owner's quality assurance testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

E. Furnish product test reports in accordance with Section 01330 - Submittal Procedures.

F. Furnish incidental labor and facilities:
1. To provide access to construction to be tested.
2. To obtain and handle samples at Work site or at source of product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

G. Notify independent quality control testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform tests and inspections in accordance with their required notice of response time.

H. Notify Construction Manager 48 hours in advance of when quality assurance observations, inspections and testing is to be performed.

1.11 OWNER'S QUALITY ASSURANCE

A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:
   1. Relieve Contractor of responsibility for providing adequate quality control measures.
   2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance.
   3. Constitute or imply acceptance.
   4. Affect the continuing rights of Owner after acceptance of the completed Work.

C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.

D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.

E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. All quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01455

SPECIAL TESTS AND INSPECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: This Section describes the requirements for providing special tests and inspections.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete.
   2. 530 - Building Code Requirements for Masonry Structures.
   3. 530.1 - Specification for Masonry Structures.

B. American Institute of Steel Construction (AISC):
   1. 360 - Specification for Structural Steel Buildings.
   2. 341 - Seismic Provisions for Structural Steel Buildings

C. American Society of Civil Engineers (ASCE):
   1. 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures

D. American Welding Society (AWS):
   1. D1.3 - Structural Welding Code - Sheet Steel.
   2. D1.4 - Structural Welding Code - Reinforcing Steel.

E. ASTM International (ASTM):
   1. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
   2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
   4. C1611 Standard Test Method for Slump Flow of Self-Consolidating Concrete.

F. International Building Code (IBC) 2018.

1.03 DEFINITIONS

A. Special Inspection: Inspection of the materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.

B. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

C. Special Inspection, Periodic: The part-time, or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed and at the completion of the work.

D. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system.

1.04 DESCRIPTION

A. This Section describes special inspections, special tests and structural observation of structural assemblies and components to be performed in compliance with the building code specified in Section 01410 - Regulatory Requirements.

B. These special tests and inspections are in addition to the requirements specified in Section 01450 - Quality Control, and by the individual Sections.

1.05 SPECIAL INSPECTION

A. Contractor will employ 1 or more special inspectors who will provide special inspections during construction.

B. Special inspector(s) shall be qualified for inspection of the particular type of materials or operations requiring special inspection.

C. Duties of Special Inspector:
   1. General: Required duties of the special inspector(s) shall be as described in Chapter 17 of the building code specified in Section 01410 - Regulatory Requirements.
   2. Reporting: Special inspector(s) shall provide reports of each inspection to the Contractor. Contractor shall distribute copes of inspection reports to the Owner.
      a. Reports shall, at a minimum, include the following items:
         1) Date and time of inspection, and name(s) of individual(s) preforming the inspection.
         2) Structures and areas of the structure where work or testing was observed.
         3) Discrepancies between the requirements of the Contract Documents and the work or testing observed.
         4) Other areas of deficiency in the Work.

D. Special inspections shall not be construed as fulfilling the requirements for structural observation.

1.06 TESTING

A. Testing laboratory: Special tests will be performed by Owner's testing laboratory as specified in Section 01450 - Quality Control.

B. Selection of the material to be tested shall be by the Engineer or by Owner's testing laboratory, and not the Contractor.

1.07 STRUCTURAL OBSERVATION

A. Owner will employ 1 or more registered design professionals who will provide structural observation(s) during construction.
   1. Registered design professional shall be a civil or structural engineer currently licensed as such in the State of Utah and regularly engaged in the structural design of structures equivalent or similar to those indicated on the Drawings.

B. Structural observations shall not be construed as fulfilling the requirements for special inspections.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SPECIAL TESTING AND INSPECTIONS

A. The following types of work require special inspection as described in Chapter 17 of the building code specified in Section 01410 - Regulatory Requirements, and shall be provided wherever such work occurs unless otherwise specified. Refer to the following schedules.
   1. Appendix A, Concrete Special Inspection Schedule.
   2. Appendix B, Architectural, Plumbing, Mechanical, and Electrical Component Special Inspection Schedule.
   3. Appendix C, Soils Verification and Inspection Schedule.
   4. Appendix D1, Structural Steel Special Inspection Schedule - General.
   5. Appendix D2, Structural Steel Special Inspection Schedule - Welding.
   6. Appendix D3, Structural Steel Special Inspection Schedule - Bolting.

B. Testing and qualification for seismic resistance (Section 1705.12 of the regulatory building code):
   1. The following designated systems shall be subject to the testing and qualification requirements of Section 1705.12.3 of the regulatory building code and shall require special certification as set forth in ASCE 7, Section 13.2:
      a. Mechanical equipment with an importance factor of 1.50 as specified in Section 01612 - Seismic Design Criteria.
      b. All electrical equipment.
      c. Special inspector shall examine the designated seismic system and determine whether the designated system components, including anchorage, conform to the evidence of compliance submitted.

3.02 STRUCTURAL OBSERVATION

A. The following work requires structural observation in accordance with Section 1704.5 of the building code specified in Section 01410 - Regulatory Requirements.

B. All structures in all areas:
   1. Foundations.

2. Elevated slabs.
3. Walls and columns.

3.03 OTHER SPECIFIC TESTS

A. Other unusual materials that are expected to support design live loads.

3.04 SCHEDULE

A. Contractor shall allow time necessary for Special Inspections as listed above.

B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

3.05 PROCEDURE

A. The Special Inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.

B. Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

APPENDIX A

CONCRETE SPECIAL INSPECTION SCHEDULE
(Includes: cast-in-place, precast concrete)

Verification and Inspection	Reference Standards ACI 318-14 AWS D1.4-17 IBC 2018	Frequency P = Periodic C = Continuous
1. Concrete Formwork		
a. Construction of forms.	ACI 318: 26.13.3.3(c)	P
b. Inspect formwork for shape, location, and dimensions of the concrete member being formed.	ACI 318: 26.11.1.2	P
c. Removal of slab forms and installation of re-shoring	ACI 318: 26.13.3.3(c)	P
2. Concrete Reinforcement		
a. Inspection of reinforcing steel, including prestressing and post-tensioning tendons.	ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3, 26.13.3.3(a) IBC: 1908.4	P
b. Reinforcement in "special reinforced concrete moment frames."	ACI 318: 26.13.3.2(d)	C
c. Reinforcing bar couplers and terminators:	Evaluation Service Reports	C
d. Inspection of reinforcing steel welding:	AWS D1.4 ACI 318: 26.6.4.1	
e. Verify weldability of reinforcing bars (other than ASTM A706).	ACI 318: 26.6.4.1	P
f. Single pass fillet welds (to 5/16 inch).	IBC: Table 1705.3	P
g. All other welds.	IB:C Table 1705.3	C
h. Inspect anchors and embedments cast into concrete (prior to and during placement of concrete).	ACI 318: 17.8.2, 26.13.3.3(a)	P
i. Inspection of anchors post-installed in hardened concrete members.	Evaluation Service Reports	
j. Adhesive anchors installed in horizontal or upwardly inclined orientations.	ACI 318: 17.8.2.4, 26.13.3.2(c). Evaluation Service Reports.	C

Verification and Inspection	Reference Standards **ACI 318-14** **AWS D1.4-17** **IBC 2018**	Frequency **P = Periodic** **C = Continuous**
k. Mechanical anchors, and adhesive anchors not included under 2j.	ACI 318: 17.8.2, 26.13.3.3(f)	P
3. Concrete placement:		
a. Verify use of required mix design.	ACI 318: Ch 19, 26.4.3, 26.4.4 1908.2, 1908.3	C
b. Sampling and preparation of cylinders and specimens for testing.	ACI 318: 26.12 IBC: 1908.10	C
c. At the time fresh concrete is sampled to fabricate cylinders and specimens for testing, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172 ASTM C31 ACI 318: 26.12 IBC 1908.10	C
d. Inspection of concrete placement for proper application and consolidation techniques.	ACI 318: 26.5.2: 26.13.3.2(a) IBC: 1908.6, 1908.7, 1908.8	C
e. Inspection for maintenance of specified curing temperatures, techniques, and duration.	ACI 318: 26.5.3 - 26.5.5 26.13.3.3(b) IBC: 1908.9	P

Notes:
1) Frequency - "Periodic" indicates observations at appropriate times and intervals to confirm that work complies with the Contract Documents and the approved submittals.
2) Frequency - "Continuous" indicates observations during the task, and at each location that includes that element.

APPENDIX B

ARCHITECTURAL, PLUMBING, MECHANICAL, AND ELECTRICAL COMPONENTS SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard IBC 2018	Frequency P = Periodic C = Continuous
1. Storage racks - 8 feet or greater in height: erection and anchorage.	IBC: 1705.12.7	P
2. Plumbing, mechanical, and electrical components:	IBC: 1705.12.6	
a. Anchorage of electrical equipment for emergency and standby power systems.	IBC: 1705.12.6.1	P
b. Anchorage of other electrical and mechanical equipment over 400 lb. on floors or roofs.	IBC: 1705.12.6.2	P
c. Installation and anchorage of piping systems carrying hazardous chemicals and their associated mechanical units.	IBC: 1705.12.6.3	P
d. Installation and anchorage of pipelines greater than 8 inches in diameter.		P
e. Installation and anchorage of ductwork designed to carry hazardous materials.	IBC: 1705.12.6.4	P
f. Installation and anchorage of ductwork greater than 6 sf in cross section.		P
g. Installation and anchorage of vibration isolation systems where contract documents require nominal clearance of 1/4 inch or less between the equipment support frame and its support/restraint.	IBC: 1705.12.6.5	P
h. Installation clearances between mechanical, electrical, five protection and structural members.	IBC: 1705.12.6.6	P
3. Smoke control systems;	IBC: 1705.18	P

Notes:
1) Frequency - "Periodic" indicates observations at appropriate times and intervals to confirm that work complies with the Contract Documents and the approved submittals.
2) Frequency - "Continuous" indicates observations during the task, and at each location that includes that element.

APPENDIX C

SOILS VERIFICATION AND SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard IBC 2018	Frequency P = Periodic C = Continuous
1. Verify excavations are extended to proper depth and have reached specified materials.	IBC: T-1705.6	P
2. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	IBC: T-1705.6	P
3. Prior to placement of fill, observe subgrade and verify that site has been prepared properly.	IBC: T-1705.6	P
4. Perform classification and testing of fill and backfill materials.	IBC: T-1705.6	P
5. During placement and compaction of fill and backfil, verify use of specified materials, densities, and lift thicknesses. l.	IBC: T-1705.6	C

APPENDIX D1

STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE - GENERAL

Inspections Required: See also: • Appendix D2 - Structural Steel Welding. • Appendix D3 - Structural Steel Bolting.	**Reference for Criteria:** **AISC 360 unless otherwise noted**	**Frequency** **P = Periodic** **C = Continuous**
Before steel erection begins:		
1. Fabricator quality control: Confirm certifications and program are acceptable to authority having jurisdiction.	AISC 360: N2; N6.	P
2. Review material test reports and certifications for compliance with contract drawings and specifications.	AISC 360: N8.	P
3. Anchor bolts / anchor rods: Observe location, type, diameter, material grade, spacing, and length of embedment into concrete prior to concrete placement.	AISC 360: N8.	P
4. Anchor bolts / anchor rods: Observe location, type, diameter, material grade, spacing, and length of embedment into masonry during construction of masonry.	AISC 360: N8.	P
5. Galvanized structural steel members: Observe cut surfaces and exposed corners of rectangular hollow structural sections (HSS) for cracks after galvanizing.	AISC 360: N7.	P
During steel erection:		
6. Observe member locations, sizes, and details for compliance with approved shop and erection drawings.		P
After steel erection		
7. Observe steel for compliance with contract drawings and specifications.	AISC 360: N8	P
8. Document acceptance or rejection of structures as erected.	AISC 360: N5.2; N7.	P
Notes: 1) Frequency - "Periodic" indicates observations at appropriate times and intervals to confirm that work complies with the Contract Documents and the approved submittals. 2) Frequency - "Continuous" indicates observations during the task, and at each location that includes that element.		

APPENDIX D2

STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE - WELDING

Inspections required:	Referenced Standard	Frequency P = Periodic C = Continuous
Inspection Tasks Prior to Welding	AISC 360, Table N5.4-1	
1. Welder qualification and continuity records comply with specified requirements		P
2. Welding procedure specifications (WPS) available.		C
3. Manufacturer certifications for welding consumables available.		C
4. Material identification confirmed (type/grade).		P
5. Welder identification system in use.		P
6. Fit-up of groove welds (including joint geometry): a. Joint preparation. b. Dimensions (alignment, root opening, root face, bevel). c. Cleanliness (condition of steel surfaces). d. Tacking (tack weld quality and location). e. Backing type and fit (if applicable).		P
7. Fit-up CJP groove welds of HSS T-, Y-, and K-joints without backing (including joint geometry): a. Joint preparation. b. Dimensions (alignment, root opening, root face, bevel). c. Cleanliness (condition of steel surfaces). d. Tacking (tack weld quality and location).		P
8. Configuration and finish of access holes.		P
9. Fit-up of fillet welds: a. Dimensions (alignment, gaps at root). b. Cleanliness (condition of steel surfaces). c. Tacking (tack weld quality and location).		P
10. Check welding equipment.		P
Inspection Tasks During Welding	AISC 360, Table N5.4-2	
11. Use of qualified welders.		P

Inspections required:	Referenced Standard	Frequency P = Periodic C = Continuous
12. Control and handling of welding consumables: a. Packaging. b. Exposure control.		P
13. No welding over cracked tack welds.		P
14. Environmental conditions: a. Wind speed within limits. b. Precipitation and temperature.		P
15. WPS followed: a. Settings on welding equipment. b. Travel speed. c. Selected welding materials. d. Shielding gas type/flow rate. e. Preheat applied. f. Interpass temperature maintained (min/max). g. Proper position (F, V, H, OH).		P
16. Welding techniques: a. Interpass and final cleaning. b. Each pass within profile limitations. c. Each pass meets quality requirements.		P
Placement and installation of headed anchor studs		C
Inspection Tasks and Testing After Welding	AISC 360, Table N5.4-3 AISC	
17. Welds cleaned.		P
18. Size, length, and location of welds.		C
19. Welds meet visual acceptance criteria: a. Crack prohibition. b. Weld/base-metal fusion. c. Crater cross section. d. Weld profiles. e. Weld size. f. Undercut. g. Porosity.		C
20. Arc strikes.		C
21. k-area: Visually inspect web k-area for cracks within 3 inches of weld.		C

Inspections required:	Referenced Standard	Frequency P = Periodic C = Continuous
22. Weld access holes in rolled and built-up heavy shapes" Visually inspect for cracks.		C
23. Backing removed and weld tabs removed (if required).		C
24. Repair activities.		C
25. Non-destructive testing of welded joints: 26. CJP groove welds. 27. Welded joints subject to fatigue.	AISC 360: N5b N5c	C
26. Document acceptance or rejection of welded joint or member.	AISC 360: N	C

Notes:

1) Frequency - "Periodic" indicates observations at appropriate times and intervals to confirm that work complies with the Contract Documents and the approved submittals.

2) Frequency - "Continuous" indicates observations during the task, and at each location that includes that element.

APPENDIX D3

STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE - BOLTING

Verification and Inspection	Referenced Standard	Frequency P = Periodic C = Continuous
Inspection Tasks Prior to Bolting	AISC 360, Table N5.6-1	
1. Manufacturer's certifications available for fastener materials.		C
2. Fasteners marked in accordance with ASTM requirements.		P
3. Correct fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane).		P
4. Correct bolting procedure selected for joint detail.		P
5. Connecting elements, including the appropriate faying surface condition and hole preparation meets applicable requirements.		P
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used.		P
7. Proper storage provided for bolts, nuts, washers and other fastener components.		P
Inspection Tasks During Bolting	AISC 360, Table N5.6-2	
8. Fastener assemblies placed in all holes, and washers and nuts are positioned as required.		P
9. Joint brought to the snug-tight condition prior to the pretensioning operation.		P
10. Fastener component not turned by the wrench prevented from rotating.		P
11. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges.		P
Inspection Tasks After Bolting	AISC 360, Table N5.6-3	
12. Document acceptance or rejection of bolted connections.		C

Verification and Inspection	Referenced Standard	Frequency P = Periodic C = Continuous
Notes: 1) Frequency - "Periodic" indicates observations at appropriate times and intervals to confirm that work complies with the Contract Documents and the approved submittals. 2) Frequency - "Continuous" indicates observations during the task, and at each location that includes that element.		

SECTION 01460

CONTRACTOR QUALITY CONTROL PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor Quality Control Plan.

1.02 SUBMITTALS

A. Qualifications of the Contractor's Quality Control (CQC) Plan Manager must include all qualifying registrations and show that the candidate has had experience (minimum 10 years) on projects of similar type and size.

B. Contractor's Daily Quality Control Report: Submit to Engineer within 1 day of completion of each inspection.

C. Daily Inspection Report: Submit to Engineer at the end of each working day or no later than prior to the beginning of the next working day.

1.03 CONTRACTOR'S INSPECTION OF THE WORK

A. Work performed by Contractor shall be inspected by the Contractor's CQC Plan Manager. Non-conforming Work and any safety hazards in the Work area shall be noted and promptly corrected.

B. No materials or equipment shall be used in Work without inspection and acceptance by Contractor's CQC Plan Manager.

1.04 QUALIFICATIONS

A. Contractor's CQC Plan Manager: Demonstrate having performed similar CQC functions on similar type projects. Submit records of personnel experience, training, and qualifications.

1.05 COVERING WORK

A. Whenever Contractor intends to backfill, bury, cast in concrete, or otherwise cover any Work, notify Engineer not less than 24 hours in advance to request inspection before beginning any such Work of covering. Failure of Contractor to notify Engineer in accordance with this requirement shall be resolved according to Article 14 of the General Conditions.

1.06 REJECTED WORK

A. Failure to promptly remove and replace rejected Work will be considered a breach of this Contract, and Owner may proceed under provisions of the General Conditions.

1.07 CONTRACTOR'S QUALITY CONTROL PROGRAM

A. General: Establish and execute a Quality Control (CQC) Plan for Work. The plan shall establish adequate measures for verification and conformance to defined requirements by Contractor personnel and lower-tier Subcontractors (including Fabricators, Suppliers, and Subcontractors). This program shall be described in a Plan responsive to this Section.

B. CQC personnel:
   1. Contractor's CQC Plan Manager shall report to a Senior Project Manager of the Contractor and shall have no supervisory or managerial responsibility over the workforce.
   2. The Contractor CQC Plan Manager shall be on-site as often as necessary, but not less than the daily working hours specified in the Contract Documents to remedy and demonstrate that Work is being performed properly and to make multiple observations of Work in progress.
   3. The Contractor is to furnish personnel with assigned CQC functions reporting to the CQC Manager. Persons performing CQC functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.

C. CQC Plan:
   1. Contractor's CQC Plan shall include a statement by the Senior Project Manager designating the CQC Plan Manager and specifying the authority delegated to the CQC Plan Manager to direct cessation or removal and replacement of defective Work.
   2. Describe the CQC program and include procedures, work instructions, and records. Describe methods relating to areas that require special testing and procedures as required by the specifications.
   3. Include specific instructions defining procedures for observing Work in process and comparing this Work with the Contract requirements (organized by specifications section).
   4. Describe procedures to ensure that equipment or materials that have been accepted at the Site are properly stored, identified, installed and tested.
   5. Include procedures to verify that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier Suppliers and/or Subcontractors.
   6. Commissioning quality control: Include procedures to verify that the commissioning requirements of the Contract Documents are integrated into the Contractor's CQC Plan and conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to the Contractor and the lower-tier Suppliers and/or Subcontractors.
   7. Include instructions for recording inspections and requirements for demonstrating through the Daily Inspection Reports that Work inspected was in compliance or a deficiency was noted and action to be taken.
   8. Procedures to preclude the covering of deficient or rejected Work.
   9. Procedures for halting or rejecting Work.
   10. Procedures for resolution of differences between the CQC Plan Manager and the production personnel.
   11. Identify contractual hold/inspection points as well as any Contractor-imposed hold/inspection points.

D. Daily Inspection Report: Include, at a minimum:
   1. Inspection of specific work.
   2. Quality characteristics in compliance.
   3. Quality characteristics not in compliance.
   4. Corrective/remedial actions taken.
   5. Statement of certification.
   6. CQC Manager's signature.
   7. Information provided on the daily report shall not constitute notice of delay or any other notice required by the Contract Documents.

E. Deficient and Non-conforming Work and Corrective Action: Include procedures for handling deficiencies and non-conforming Work. Deficiencies and non-conforming Work are defined as documentation, drawings, material, equipment, or Work not conforming to the indicated requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent reoccurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documents and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
   1. Personnel responsible for identifying deficient and non-complying items within Work.
   2. How and by whom deficient and non-compliant items are documented "in the field."
   3. The personnel and process utilized for logging deficient and non-compliant Work at the end of each day onto a deficiency log.
   4. Tracking processes and tracking documentation for deficient and non-conforming Work.
   5. Personnel responsible for achieving resolution of outstanding deficiencies.
   6. Include detailed procedures for the performance and control of special process (e.g., welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).

F. Audits: The CQC program shall provide for regularly scheduled documented audits to verify that CQC procedures are being fully implemented by Contractor and its Subcontractors. Audit records shall be made available to Engineer upon request.

G. Documented control/quality records:
   1. Establish methods for control of Contract Documents that describe how Drawings and Specifications are received and distributed to ensure the correct issue of the document being used. Describe how record document/drawing data are documented and furnished to Engineer.
   2. Maintain evidence of activities affecting quality. Including operating logs, records of inspection, audit reports, personnel qualification and certification records, procedures, and document review records.
   3. Maintain quality records in a manner that provides for timely retrieval and traceability. Protect quality records from deterioration, damage and destruction.
   4. Develop a list of specific records as required by the Contract Documents that will be furnished to Engineer at the completion of activities.

H. Acceptance of CQC Plan: Engineer's acceptance of the CQC Plan shall not relieve Contractor from any of its obligations for performance of Work. Contractor's CQC staffing is subject to Engineer's review and continued acceptance. Owner, at its sole discretion, and without cause, may direct Contractor to remove and replace the CQC Plan Manager.
   1. Acceptance of the CQC Plan by the Engineer is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.
   2. After acceptance of the CQC Plan, notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 REFERENCE

A. American National Standards Institute (ANSI).

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

1.04 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Arrange with Owner to provide adequate temporary electrical service. Owner will supply the electricity from its facilities for the Contractors use in connection with the performance of the Work at no charge to the contractor.
   2. Contractor shall provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
   3. Contractor to provide all labor and materials associated with temporary power, including the installation of a backflow preventer.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
   2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
      a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.

C. Temporary heating, cooling, and ventilating:
   1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
   2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:
   1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
   2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
   3. Owner will provide water used for construction prior to Substantial Completion. Owner will provide water for 7-day operational testing.
   4. Development of potable water supply:
      a. Potable water is not available at construction site.
      b. Provide potable water for human consumption during construction period.
      c. Furnish potable water that meets requirements of Laws and Regulations.
   5. Development of non-potable water supply:
      a. Post ample signs throughout the work area warning that plant water is not potable.
      b. Non-potable water is available from hydrants or hose valves within plant without cost. When combined demand of the Work and plant exceeds plant supply capacity, provide additional temporary supply capacity.

E. Temporary sanitary facilities:
   1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
   2. Existing facility use is not allowed.
   3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. Temporary fire protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in existing facilities: As specified in Section 01140 - Work Restrictions.

1.05 TEMPORARY PIPING SYSTEMS

1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
2. Submit product data for piping, fittings, appurtenances, restraints, supports, and all other components of the temporary piping system.
3. Submit all information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment.

1.06 TEMPORARY PUMPING SYSTEMS

1. Submit pump data, performance curves, and other operating information as specified in Section 15050 - Common Work Results for Mechanical Equipment.
2. Submit sketches showing layout of temporary pumping system, including pump quantity, configuration in wet well, and proposed piping layout specified in this Section.
3. Submit piping headloss calculations based on proposed temporary piping system layout.

4. Submit information at least 28 days prior to when the temporary pumping system is scheduled to be installed and allow 14 days for review and comment.

1.07 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment, and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

H. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

I. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

J. Fences:
   1. The entire Work will be conducted inside the existing plant fence.
   2. Contractor access is through the existing main plant entrance gate.
   3. No temporary modifications to the existing fence shall be permitted.

1.08 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.09 ACCESS ROADS

A. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.
   2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
   3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
   4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.10 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

C. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.11 PROJECT SIGN

A. Provide and maintain Project identification sign consisting of painted 8-foot wide by 4-foot high exterior grade plywood and minimum 10-foot long, 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:
   1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
   2. Contractor’s Engineer’s names shall be identified in upper right-hand corner underneath the bid number.

B. On third and fourth lines of printing, paint appropriate dollar amounts.

C. Erect Project identification sign where directed by Engineer within 14 days after the issuance of the Notice to Proceed.

D. Replace or repair the project sign if it is damaged or covered with graffiti within 2 working days of observation or notification of damage or graffiti.

1.12 CONTRACTOR FIELD OFFICES AND SHEDS

A. Maintain on Project Site weather tight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.

B. Provide field office with adequate space to examine documents, and provide lighting and telephone service in that space.

C. Engineer field office:
   1. The Engineer's and Owner's field office will be located within the existing water treatment plant office space. The Contractor will not be required to furnish any field office facilities, equipment, or services.

1.13 REMOVAL

A. Remove temporary facilities and controls before inspection for Substantial Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

1.14 TEMPORARY PROCESS PIPING

A. Contractor shall provide all piping, appurtenances, and other materials as required to provide temporary piping systems as specified in this Section, as indicated on the Drawings, and as needed to perform the Work.

B. Contractor shall field route piping as needed and as field conditions dictate, unless otherwise indicated on the Drawings, and determine appropriate lengths of piping and quantity/type of pipe fittings needed to construct temporary piping system. Do not block access points such as stairs, doors, and walkways to existing facilities unless approved in writing by the Owner.

C. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
   1. When piping is buried, use concrete thrust block or mechanical restraints.
   2. When piping is exposed or under water, use mechanical or structural restraints.
   3. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by the operating pressure of the piping.

D. Temporary piping systems shall be installed in a manner that will not damage existing or new facilities.

E. Unless indicated otherwise, piping material, including gaskets, shall be suitable for the process fluid requiring temporary piping.

F. After temporary piping system is no longer required:
   1. Remove temporary piping system.
   2. Clean and repair damage caused by installation or use of temporary piping system.
   3. Restore existing facilities to original condition.

1.15 TEMPORARY PROCESS PUMPING

A. Contractor shall provide temporary pumping system to pump flow from between manholes at the existing 14” SL pipeline. Stage construction between manholes, shutdowns over 72 hours are not permitted:
   1. Anticipated process flow rates:
      a. Maximum: 3.5 mgd
      b. Minimum: 0.75 mgd
   2. Anticipated pressure will vary based on headlosses developed and the final length of installed temporary piping. Contractor shall calculate headlosses and provide pump with sufficient pressure to meet flow requirements. Calculations shall be sealed and signed by a professional engineer registered in the state in which the Project is located.
   3. Pump shall be capable of passing a solid with a sphere size of 3 inches.
   4. Provide and pay for all power required to operate temporary pumps.
   5. All electrical and instrumentation components will comply with applicable code requirements for the area where the temporary pump is located.
   6. Contractor shall be responsible for repairing any damage or reimbursing the Owner for any regulatory fines or additional plant staff time resulting from the Contractor’s failure to maintain temporary pumping.
   7. All necessary spare equipment and appurtenances shall be available on-site to allow immediate repair and/or replacement of any pumping system component that is not functioning properly.

B. Providing temporary piping systems as specified in this Section.

C. Temporary pumping of other process flows is not allowed unless approved in writing by the Owner.

D. After temporary process pumping system is no longer required:
   1. Remove temporary process pumping system.
   2. Clean and repair damage caused by installation or use of temporary process pumping system.
   3. Restore existing facilities to original condition.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01573

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation of erosion and sediment control filter fabric fences.
   2. Triangular filter fabric fences.
   3. Straw bale fences and brush berms used during construction and prior to final development of site.

B. Purpose of control fences is to contain pollutants from overland flow.
   1. Control fences are not for use in channelized flow areas.

1.02 UNIT PRICES

A. Measure and pay for filter fabric fence by linear foot of completed and accepted filter fabric fence installed around construction site. Limits of construction site are indicated on the Drawings.

B. Measure and pay for triangular filter fabric fence by linear feet of completed and accepted triangular filter fabric fence between limits of beginning and ending of wooden stakes.

C. Measure and pay for straw bale barrier by linear feet of completed and accepted straw bale barrier.

D. Measure and pay for brush berm by linear feet of completed and accepted brush berm.

1.03 SUBMITTALS

A. Manufacturer’s catalog sheets and other product data on geotextile fabric.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 [600 kN-m/m^3]).
   2. D4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.
   3. D4491- Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes, and Related Products.

6. D5665- Standard Specification for Thermoplastic Fabrics Used in Cold-Applied Roofing and Waterproofing.
7. D6459 - Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
8. D6475 - Standard Test Method for Measuring Mass per Unit Area of Erosion Control Blankets.
9. D6525 - Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.
10. D6567 - Standard Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP).
11. D6818 - Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products.

1.05 QUALITY ASSURANCE FOR EROSION CONTROL BLANKETS

A. Product shall be manufactured in accordance to a documented Quality Control Program. At a minimum, the following procedures and documentation shall be provided:
   1. Manufacturing Quality Control Program Manual.
   2. First piece inspection of products produced to assure component materials and finished product tolerances are within manufacturer specifications.
   3. Additional inspections for product conformance shall be conducted during the run after the first piece inspection.
   4. Every roll shall be visually inspected.
   5. Moisture content of straw and coconut fibers measured upon receipt.
   6. At a minimum, every third roll shall be weighed to insure conformance of manufacturer's specifications.
   7. Each individual erosion control blanket shall be inspected prior to packaging for conformance to manufacturing specifications.

1.06 PERFORMANCE REQUIREMENTS FOR EROSION CONTROL BLANKETS

A. Erosion control blanket shall provide a temporary, biodegradable cover material to reduce slope and enhance vegetation. Erosion control blanket performance capabilities shall be in accordance with ASTM D6459, "Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion."

PART 2 PRODUCTS

2.01 FILTER FABRIC

A. Provide woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material.

B. Geotextile fabric:
   1. Grab strength of 100 pounds per square inch in any principal direction in accordance with ASTM D4632.
   2. Puncture strength exceeding 115 pounds per square inch in accordance with ASTM D4833.

3. Equivalent opening size between 50 and 140 for soils with more than 15 percent by weight passing No. 200 sieve and between 20 and 50 for soil with less than 15 percent by weight passing No. 200 sieve.
4. Maximum water flow rate of 40 gallons per minute per square feet in accordance with ASTM D4491.

C. Filter fabric material shall contain ultraviolet inhibitors and stabilizers to provide expected usable life comparable to anticipated construction period.
1. Ultraviolet stability shall exceed 70 percent after 500 hours of exposure in accordance with ASTM D4355.

D. Manufacturers: The following or equal:
1. Mirafi, Inc.

2.02 EROSION CONTROL BLANKETS

A. Manufacturers: One of the following or equal:
1. American Excelsior Co., AEC Premier Straw/Coconut™ Blankets.
2. Proper Geotextile Systems.

B. Product requirements:
1. Erosion control blanket shall be furnished in rolls and wrapped with suitable material to protect against moisture intrusion and extended ultraviolet exposure prior to placement.
2. Erosion control blanket shall be of consistent thickness with fibers distributed evenly over the entire area of the blanket.
3. Erosion control blanket shall be free of defects and voids that would interfere with proper installation or impair performance.

C. Materials:
1. Blend of 70 percent straw and 30 percent coconut fibers.
   a. The straw fibers shall consist of straw with 75 percent of fibers greater than 4 inches in length, and certified weed seed free.
   b. Product shall be 100 percent biodegradable.
   c. The blended fibers shall be evenly distributed throughout the entire area of the blanket.
   d. The top and bottom of each blanket is covered with biodegradable jute netting.
2. Blanket performance requirements:
   a. C factor: 0.15.
   b. Shear stress: 2.0 lb/ft^2.
   c. Velocity: 8.5 feet per second.
   d. Functional longevity: Less than 24 months.
3. Material characteristics:
   a. Width: 8.0 feet.
   b. Length: 112.5 feet.
   c. Area: 100.0 yard^2.
   d. Weight: 50.0 pounds.
   e. Mass per unit area: 0.50 lv/yd^2.
   f. Net openings: 0.5 inch by 1.0 inch.

g. Minimum Index Values:

Index Property	Test Method	Value
Thickness	ASTM D6525	0.331 in (8.41 mm)
Light Penetration	ASTM D6567	5.8%
Mass per Unit Area	ASTM D6475	0.81 lb/yd^2 (437 g/m^2)
MD-Tensile Strength Max.	ASTM D6818	321.6 lb/ft (4.69 kN/m)
TD-Tensile Strength Max.	ASTM D6818	159.6 lb/ft (2.33 kN.m)
MD-Elongation	ASTM D6818	4.1%
TD-Elongation	ASTM D6818	4.8%
Water Absorption	ASTM D5665	382%

D. Staples:
   1. Staples shall be 100 percent biodegradable with a U-shaped top. Staples shall be a minimum 4-inch biodegradable staple for cohesive soils and 6 inches for non-cohesive soils.

PART 3 EXECUTION

3.01 PREPARATION AND INSTALLATION

A. Provide erosion and sediment control systems at locations as indicated on the Drawings.
   1. Construct in accordance with requirements as indicated on the Drawings and of type indicated as specified in this Section.

B. No clearing, grubbing or rough cutting permitted until erosion and sediment control systems are in place, other than site work specifically directed by Project Manager to allow soil testing and surveying.

C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Project Manager to remove and discard existing system.

D. Regularly inspect and repair or replace damaged components of erosion and sediment control systems as specified in this Section.
   1. Unless otherwise directed, maintain erosion and sediment control systems until project area stabilization is accepted by the Authority.
   2. Remove erosion and sediment control systems promptly when directed by Project Manager.
   3. Discard removed materials off site.

E. Remove and dispose sediment deposits at designated spoil site for Project.
   1. If a project spoil site is not indicated on the Drawings, dispose of sediment off site at location not in or adjacent to stream or floodplain.
   2. Assume responsibility for off-site disposal.
   3. Spread sediment evenly throughout site, compacted and stabilized.

4. Prevent sediment from flushing into a stream or drainage way.
5. If sediment has been contaminated, dispose of in accordance with existing federal, state, and local rules and regulations.

F. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8-inch layers.
1. Compaction density shall be at a minimum of 90 percent Standard Proctor ASTM D698 density.
2. Make at least 1 test per 500 cubic yards of embankment.

G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction.
1. Immediately repair damage caused by construction traffic to erosion and sediment control.

3.02 GENERAL CONSTRUCTION METHODS

A. Provide erosion and sedimentation control systems as indicated on the Drawings.
1. Install erosion and sedimentation control systems in manner that surface runoff shall percolate through system in sheet flow fashion and allow retention and accumulation of sediment.

B. Inspect erosion and sedimentation control systems after each rainfall, daily during periods of prolonged rainfall, and at minimum once each week.
1. Repair or replace damaged sections immediately.
2. Remove sediment deposits when silt reaches depth 1/3 height of fence or 6 inches, whichever is less.

3.03 SITE PREPARATION FOR EROSION CONTROL BLANKETS

A. Before placing erosion control blanket, Contractor shall certify that the subgrade has been properly compacted, graded smooth, has no depressions, voids, soft or uncompacted areas, is free from obstructions such as tree roots, protruding stones or other foreign matter, and is seeded and fertilized according to project specifications.
1. Contractor shall not proceed until all unsatisfactory conditions have been remedied.
2. By beginning construction, Contractor signifies that the proceeding work is in conformance with this Section.

B. Contractor shall fine grade the subgrade by hand dressing where necessary to remove local deviations.

C. No vehicular traffic shall be permitted directly on the erosion control blanket.

D. Slope installation
1. Erosion control blanket shall be installed as directed by Owner's representative in accordance with manufacturer's Installation Guidelines, Staple Pattern Guides, and CAD details. The extent of erosion control blanket shall be as indicated on the Drawings.
2. Erosion control blanket shall be oriented in vertical strips and anchored with staples, as identified in the Staple Pattern Guide.

a. Adjacent strips shall be overlapped to allow for installation of a common row of staples that anchor through the nettings of both blankets.
b. Horizontal joints between erosion control blankets shall be sufficiently overlapped with the uphill end on top for a common row of staples so that the staples anchor through the nettings of both blankets.

3. Where exposed to overland sheet flow, a trench shall be located at the uphill termination erosion control blanket shall be stapled to the bottom of the trench.
   a. The trench shall be backfilled and compacted.
   b. Where feasible, the uphill end of the blanket shall be extended 3 feet over the crest of the slope.

3.04 FILTER FABRIC FENCE CONSTRUCTION METHODS

A. Attach filter fabric to 1-inch by 2-inch wooden stakes or driven steel rods spaced a maximum of 3 feet apart and embedded minimum of 8 inches or deeper to hold fence in place.
   1. If filter fabric is factory preassembled with support netting, then maximum spacing allowable is 8 feet.
   2. Install anchoring stakes or rods at slight angle toward source of anticipated runoff.
   3. Contractor is responsible for providing adequate fence anchoring appropriate for the varying soil and rock conditions at the well sites.

B. Trench in toe of filter fabric fence with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow.
   1. V-trench configuration as indicated on the Drawings may also be used.
   2. Lay filter fabric along edges of trench.
   3. Backfill and compact trench.

C. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.

D. Provide filter fabric in continuous rolls and cut to length of fence to minimize use of joints.
   1. When joints are necessary, splice fabric together only at support post with minimum 6-inch overlap and seal securely.

3.05 TRIANGULAR FILTER FABRIC FENCE CONSTRUCTION METHODS

A. Attach filter fabric to fence structure fashioned from 6 gauge, 6-inch by 6-inch wire mesh, 18 inches on each side as indicated on the Drawings.
   1. Fabric cover and skirt should be continuous wrapping of fabric.
   2. Skirt should form continuous extension of fabric on upstream side of fence.

B. Secure triangular fabric filter fence in place using one of the following methods:
   1. Toe-in skirt 6 inches with mechanically compacted material.
   2. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock.
   3. Trench-in entire structure 4 inches.

C. If provided, anchor triangular fabric filter fence structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt, or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.

D. Lap over fabric filter material by 6 inches to cover segment joints.
   1. Fasten joints with galvanized shoat rings.

3.06 STRAW BALE FENCE CONSTRUCTION METHODS

A. Bound bales with either wire, nylon or polypropylene rope tied across hay bales.
   1. Do not use jute or cotton bindings.

B. Place bales in row with ends tightly abutting adjacent bales.
   1. Place bales with bindings parallel to ground surface.

C. Embed bale in soil a minimum of 4 inches.

D. Securely anchor bales in place by 3/8-inch rebar stakes driven through bales a minimum of 18 inches into ground.
   1. Angle first stake in each bale toward previously laid bale to force bales together.

E. Fill gaps between bales with straw to prevent water from escaping between bales.
   1. Wedge carefully in order not to separate bales.

F. Replace with new straw bale fence every 2 months.

3.07 BRUSH BERM CONSTRUCTION METHODS

A. Construct brush berm along contour lines by hand placing method.
   1. Do not use machine placement of brush berm.

B. Use woody brush and branches having diameter less than 2-inches with 6-inches overlap.
   1. Avoid incorporation of annual weeds and soil into brush berm.

C. Use minimum height of 18-inches measured from top of existing ground at upslope toe to top of berm.
   1. Top width shall be 24 inches minimum and side slopes shall be 2:1 or flatter.

D. Embed brush berm into soil a minimum of 4-inches and anchor using either wire, nylon or polypropylene rope across berm with a minimum tension of 50 pounds.
   1. Tie rope securely to 18-inch x 3/8-inch diameter rebar stakes driven into ground on 4-foot centers on both sides of berm.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Product requirements.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 DEFINITIONS

A. Products: Inclusive of raw materials, finished goods, equipment, systems, and shop fabrications.

B. Special tools: Tools that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.

1.04 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures.

B. Calculations/certifications in accordance with NSF 61 and NSF 372 for materials in contact with drinking water.

1.05 GENERAL REQUIREMENTS

A. Comply with Specifications and referenced standards as minimum requirements.

B. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.

C. Provide like parts of duplicate units that are interchangeable.

D. Provide equipment or product that has not been in service prior to delivery, except as required by tests.

E. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings.

1.06 "OR EQUAL" AND SUBSTITUTIONS

A. Formal substitution request procedure:
   1. Submit a written formal substitution request to Engineer for each proposed substitution within 30 days of effective date of Contract.
   2. Engineer will return initial opinion and request for additional information within 30 days.
   3. Engineer will notify Contractor in writing of decision to accept or reject the substitution request within 30 days of receiving required information.

B. Formal substitution request contents:
   1. Provide Substitution Request Form, Appendix A, as specified in this Section.
   2. Manufacturer's literature including:
      a. Manufacturer's name and address.
      b. Product name.
      c. Product description.
      d. Reference standards.
      e. Certified performance and test data.
      f. Operation and maintenance data.
   3. Samples, if applicable.
   4. Shop drawings, if applicable.
   5. Reference projects where the product has been successfully used:
      a. Name and address of project.
      b. Year of installation.
      c. Year placed in operation.
      d. Name of product installed.
      e. Point of contact: Name and phone number.
   6. Itemized comparison of the proposed substitution with product specified including a list of significant variations:
      a. Design features.
      b. Design dimensions.
      c. Installation requirements.
      d. Operations and maintenance requirements.
   7. Define impacts:
      a. Impacts to construction schedule.
      b. Impacts to other contracts.
      c. Impacts to other work or products.
      d. Impact to Contract Sum:
         1) Do not include costs under separate contracts.
         2) Do not include Engineer's costs for redesign or revision of Contract Documents.
         3) Required license fees or royalties.
      e. Availability of maintenance services and sources of replacement materials.
   8. Contractor represents the following:
      a. Contractor shall pay associated costs for Engineer to evaluate the substitution.
      b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
      c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
      d. Proposed substitution is equal or superior to the specified product.

e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless Owner requires a Special Warranty.
f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

C. Substitutions will not be considered for acceptance under the following conditions:
1. No formal substitution request is made.
2. The substitution is simply implied or indicated on shop drawings or product data submittals.
3. The formal substitution request is submitted by a subcontractor or supplier.

D. Substitution requests submitted after the deadline will not be considered unless the following evidence is submitted to the Engineer:
1. Proof that the specified product is unavailable for reasons beyond the control of the Contractor.
a. Reasons may include manufacturing discontinued, bankruptcy, labor strikes, or acts of God.
b. Contractor placed or attempted to place orders for the specified products within 10 days after the effective date of the Agreement.
c. The formal substitution request is submitted to Engineer within 10 days of Contractor discovering the specified product cannot be obtained.

E. Engineer's decision on a substitution requests will be final and binding.
1. Approved substitutions will be incorporated into the Contract Documents with a Change Order.
2. Requests for time extensions and additional costs based on submission of, approval of, or rejection of substitutions will not be allowed.

PART 2 PRODUCTS

2.01 GENERAL

A. Material requirements:
1. Materials: Provide corrosion resistance suitable for project conditions as specified in Section 01610 - Project Design Criteria.
2. Dissimilar metals: Separate contacting surfaces with dielectric material.

B. Edge grinding:
1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence.

2.02 PRODUCTS IN CONTACT WITH DRINKING WATER

A. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.
1. Certification by an independent ANSI accredited third party, including, but not limited to, NSF International, as being lead free.

2.03 PRODUCT SELECTION

A. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products that meet or exceed reference standard and Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide:
   1. Products by one of named manufacturers that meet or exceed Specifications.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide:
   1. Products with model numbers or catalog designations by one of named manufacturers.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by one of named manufacturers proven, in accordance with requirements for an "or equal", to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
   3. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

E. When Products are specified with only one manufacturer followed by "or Equal," provide:
   1. Products meeting or exceeding Specifications by specified manufacturer.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

2.04 SHIPMENT

A. Mandatory requirements prior to shipment of equipment:
   1. Engineer approved shop drawings.
   2. Engineer approved Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning, when required by specifications.
   3. Draft operations and maintenance manuals, as specified in Section 01782 - Operation and Maintenance Data, when required by specifications.

B. Prepare products for shipment by:
   1. Tagging or marking products to agree with delivery schedule or shop drawings.
   2. Including complete packing lists and bills of material with each shipment.
   3. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
   4. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

C. Transport products by methods that avoid product damage.

D. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

2.05 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts and maintenance products as required by Specifications.

B. Provide one set of special tools required to install or service the equipment.

C. Box, tag, and clearly mark items.

D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by Owner.

E. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period.
   1. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.

F. Provide spare parts and special tools inventory list, see Appendix B:
   1. Equipment tag number.
   2. Equipment manufacturer.
   3. Subassembly component, if appropriate.
   4. Quantity.
   5. Storage location.

G. Store large items individually:
   1. Weight: Greater than 50 pounds.
   2. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
   3. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

H. Store in spare parts box smaller items:
   1. Weight: Less than 50 pounds.
   2. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
   3. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

I. Spare parts and special tools box:
   1. Wooden box:
      a. Size: 24 inches wide by 18 inches high by 36 inches long.
   2. Hinged wooden cover:
      a. Strap type hinges.
      b. Locking hasp.
      c. Spare parts inventory list taped to underside of cover.
   3. Coating: As specified in Section 09960 - High-Performance Coatings.

4. Clearly labeled:
    a. The words “Spare Parts and/or Special Tools”.
    b. Equipment tag number.
    c. Equipment manufacturer.

PART 3 EXECUTION

3.01 DELIVERY AND HANDLING

A. Handle equipment in accordance with manufacturer's instructions.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage.

C. Upon delivery, promptly inspect shipments:
    1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
    2. Acceptance of shipment does not constitute final acceptance of equipment.

3.02 STORAGE AND PROTECTION

A. Immediately store and protect products and materials until installed in Work.

B. Store products with seals and legible labels intact.

C. Maintain products within temperature and humidity ranges required or recommended by manufacturer.

D. Protect painted or surfaces against impact, abrasion, discoloration, and damage.
    1. Repaint damaged painted or surfaces.

E. Exterior storage of fabricated products:
    1. Place on aboveground supports that allow for drainage.
    2. Cover products subject to deterioration with impervious sheet covering.
    3. Provide ventilation to prevent condensation under covering.

F. Store moisture sensitive products in watertight enclosures.

G. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, architectural items, electrical and instrumentation equipment and special equipment to be incorporated into this project.
    1. Storage of equipment shall be in strict accordance with the “instructions for storage” of each equipment supplier and manufacturer including connection of heaters, placing of storage lubricants in equipment, etc.
    2. The Contractor shall furnish a copy of the manufacturer’s instructions for storage to the Engineer prior to storage of all equipment and materials.

H. Store loose granular materials on solid surfaces in well-drained area.
    1. Prevent materials mixing with foreign matter.
    2. Provide access for inspection.

I. Payment will not be made for equipment or and materials improperly stored or stored without providing Engineer with the manufacturer's instructions for storage.

J. Provide an Equipment Log including, as a minimum, the equipment identification, date stored, date of inspection/maintenance, date removed from storage, copy of manufacturer's recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

3.03 PROTECTION AFTER INSTALLATION

A. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations.
   1. Remove covering when no longer needed.
   2. Replace corroded, damaged, or deteriorated equipment, product, or parts before acceptance of the project.

B. Update Equipment Log on a monthly basis with description of maintenance activities performed in accordance with the manufacturer's recommendation and industry standards and signature of party performing maintenance.

3.04 QUALITY ASSURANCE

A. Employ entities that meet or exceed specified qualifications to execute the Work.

B. Verify project conditions are satisfactory before executing subsequent portions of the Work.

3.05 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.06 CLOSEOUT ACTIVITIES

A. Owner may request advanced delivery of spare parts, maintenance products, and special tools.
   1. Deduct the delivered items from the inventory list and provide transmittal documentation.

B. Immediately prior to the date of Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to Owner at a location on site chosen by the Owner.
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

3.07 ATTACHMENTS

A. Appendix A - Sample Or Equal Substitution Request Form.

B. Appendix B - Spare Parts, Maintenance Products, and Special Tools Inventory List.

END OF SECTION

APPENDIX A

OR EQUAL SUBSTITUTION REQUEST FORM

DOCUMENT 01600
OR EQUAL SUBSTITUTION REQUEST FORM

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

To: _____ **From:** _____

Re: _____

Contract For: _____

Engineering Project Number: _____ **Substitution Request Number:** _____

Specification Information
Title: _____
Number: _____ Page: _____ Article/Paragraph: _____
Description: _____

Proposed Substitution				
Product: _____				
Manufacturer: _____				
Address: _____			Phone: _____	
Trade Name: _____			Model No.: _____	
Installer: _____				
Address: _____			Phone: _____	
History:	New Product	2-5 years old	5-10 years old	More than 10 years old
Differences between proposed substitution and specified product:				
Point-by-point comparative data and impacts attached – REQUIRED BY ENGINEER				

Reason For Not Providing Specified Item

Reason: _____

Similar Installation: _____

Project: _____

Address: _____ Date Installed: _____

Owner: _____ Architect: _____

Proposed substitution affects other parts of Work:

____ No ____ Yes, Explain: _____

Benefit to Owner For Accepting Substitution

Savings: _____ ($) _____

Proposed substitution changes Contract Time:

____ No ____ Yes **(Add)** **(Deduct)** _____ days

Supporting Data Attached

___ Drawings ____ Product Data ____ Samples _____ Tests ____ Reports

___ Reference Projects Other: _____

Certifications

The undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product, unless Owner requires a Special Warranty.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including Engineer design, detailing, and construction costs caused by the substitution.

Certifications
• Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm Name _____

Firm Address: _____

_____

Phone: _____

Attachments: _____

Engineer's Review And Action

___ Substitution accepted - Make submittals as specified in Section 01330 - Submittal Procedures.

___ Substitution accepted as noted - Make submittals as specified in Section 01330 - Submittal Procedures.

___ Substitution rejected - Use specified materials.

___ Substitution Request received too late - Use specified materials.

Signed by: _____ Date: _____

Additional Comments

Additional Comments:

___ Contractor ___ Subcontractor ___ Supplier ___ Manufacturer ___ Engineer

Other: _____

Comments: _____

APPENDIX B
SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

Inventory List				
Spec Number: _____		Spec Title _____		
Equipment Tag No.: _____		Equipment Manufacturer: _____		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**

SECTION 01610

PROJECT DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Project design criteria such as temperature and site elevation.

1.02 PROJECT DESIGN CRITERIA

A. Equipment and materials for the project are to be suitable for performance in domestic water treatment plant environment and under following conditions:
   1. Design temperatures are:
      a. Outdoor temperatures: 0 to 100 degrees Fahrenheit.
      b. Indoor temperatures for the following buildings:
         1) Process areas: 50 to 85 degrees Fahrenheit.
         2) Electrical rooms: 50 to 85 degrees Fahrenheit.
   2. Design groundwater elevation: Greater than 30 feet.
   3. Freeze-thaw conditions.
   4. Moisture conditions: Defined in individual equipment sections.
   5. Site elevation: Approximately 4,750 feet above mean sea level.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01612

SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
   3. Other structures or items as specified or indicated on the Drawings.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7-16 - Minimum Design Loads for Buildings and Other Structures.

1.03 SYSTEM DESCRIPTION

A. Design in accordance with the requirements of the building code as specified in Section 01410 - Regulatory Requirements.

B. Design spectral acceleration at short period, S_{DS}=0.940 g

C. Design of non-structural components and their connections to structures:
   1. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1 unless otherwise specified.
   2. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1 unless otherwise specified.
   3. Component importance factor, I_p:

Table 1: Component Importance Factor, I_p

Component	Description	I_p
Electrical	Equipment and appurtenances provided and installed under Division 16.	1.5

D. Seismic Design Category (SDC):
   1. Seismic Design Category (SDC) for certification of mechanical and electrical equipment as required by ASCE 7:
      a. All areas: Seismic Design Category D.

E. Design requirements: Anchorage of equipment to structures.
   1. Do not use friction to resist sliding due to seismic forces. Do not design or provide connections that use friction to resist seismic loads. Resist seismic forces through direct tension and/or direct bearing in shear on anchors and fasteners.
   1. Do not use more than 60 percent of the weight of the mechanical, electrical, and architectural items or equipment for designing anchors that resist

overturning or sliding due to seismic forces in Allowable Stress Design Load combinations and not more than 90 percent of the weight in Strength Design Load combinations.

2. Do not use more than 60 percent of the weight of the tank for designing anchors that resist overturning or sliding due to seismic forces in Allowable Stress Design Load combinations and not more than 90 percent of the weight in Strength Design Load combinations.
3. Anchoring and fastening to concrete and masonry:
    a. Use only cast-in anchors (anchor bolts, anchor rods, or welded studs) specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry, for anchoring at connections that resist seismic forces.
        1) Do not use concrete anchors, sleeve anchors, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer prior to installation.
4. Anchor bolt holes in equipment support frames:
    a. Do not exceed bolt diameter by more than 25 percent, up to a maximum diameter equal to that of the bolt plus 1/4 inch.

1.04 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and seismic calculations for anchorage to structures.

B. Calculations shall be signed and sealed by a civil or structural engineer licensed in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with building code as specified in Section 01410 - Regulatory Requirements:
      a. Risk category: III.
      b. Wind speed, V_{ult}:109miles per hour.
      c. Exposure category: C.
      d. Topographic factor, K_{zt}: 1.0.
   2. Resist wind forces through direct bearing on anchors and fasteners. Do not design or provide connections that use friction to resist wind loads.
   3. Anchoring and fastening to concrete and masonry:
      a. Provide anchors specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All-Thread Rods and 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Use only cast-in and built-in anchors (anchor bolts and welded studs) for anchors at connections that resist wind forces.
      c. Do not use concrete anchors, flush shells, sleeve anchors, flush shells, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations.

B. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01738

SELECTIVE ALTERATIONS AND DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cutting or modifying of existing and new work.
   2. Partial demolition of structures.
   3. In-place abandonment of pipe.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A10.6 - Safety and Health Program Requirements for Demolition Operations.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
   2. Guideline No. 310.3R - Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods.

1.03 DEFINITIONS

A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.

B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.

C. Coring equipment: Non-impact rotary drill with diamond cutting edges.

D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

1.04 DESCRIPTION OF WORK

A. The work includes partial demolition, cutting, and modifying of existing facilities, utilities, and/or structures.

B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and

structures that are to remain in place and that are damaged by demolition or removal operations.

1.05 SUBMITTALS

A. General:
   1. Submit specified in Section 01330 - Submittal Procedures.

B. Shop drawings: Include:
   1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.

C. Submittals for information only:
   1. Permits and notices authorizing demolition.
   2. Certificates of severance of utility services.
   3. Permit for transport and disposal of debris.
   4. Selective Demolition Plan.
   5. Pipe Abandonment Plan.

D. Quality assurance submittals:
   1. Qualifications of non-destructive testing agency/agencies.

E. Project record documents.

F. Drawings and/or other media documenting locations of service lines and capped utilities.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
   2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

1.07 SEQUENCING

A. Perform Work in sequences and within times specified in Section 01140 - Work Restrictions.

B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.

C. Coordinate the Work with operation of the facility:
   1. Do not begin alterations of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
   2. Complete Work as quickly and with as little delay as possible.

D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.

E. Owner will cooperate in every way practicable to assist in expediting the Work.

F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

1.08 REGULATORY REQUIREMENTS

A. Dispose of debris in accordance with governing regulatory agencies.

B. Comply with applicable air pollution control regulations.

C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

1.09 PROJECT CONDITIONS

A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.

B. Provide, erect, and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
   1. Do not close or obstruct roadways without permits.
   2. Conduct operations with minimum interference to public or private roadways.

C. Prevent movement, settlement, or collapse of structures adjacent services, sidewalks, driveways and trees:
   1. Provide and place bracing or shoring.
   2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
   3. Assume liability for movement, settlement, or collapse. Promptly repair damage.

D. Arrange and pay for capping and plugging utility services. Disconnect and stub off.
   1. Notify affected utility company in advance and obtain approval before starting demolition.
   2. Place markers to indicate location of disconnected services.

E. Unknown conditions:
   1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
   2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other surface fixtures.
   3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their

disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the Work until written instructions are received from the Engineer.

PART 2 PRODUCTS

2.01 SALVAGE MATERIALS

A. Salvage materials: Materials removed from existing facility.

B. Materials designated for salvage:
   1. Recycle Pump Station No. 1:
      a. Existing Sludge Pumps in the East Wet Well.
   2. Recycle Pump Station No. 2:
      a. Existing VFDs.

C. Handling and storage:
   1. Prevent damage to salvaged materials during removal, handling, and transportation of salvaged materials.

D. Pay costs associated with salvaging materials, including handling, transporting, and storage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning selective demolition operations, perform a thorough inspection of the facility and site, and report to the Engineer defects and structural damage to or deterioration of existing construction to remain.

B. Examine areas affected by the Work and verify the following conditions prior to commencing demolition:
   1. Disconnection of utilities as required.
   2. That utilities serving occupied or active portions of surrounding facilities will not be disturbed, except as otherwise indicated.

C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition operations until such conditions have been corrected.

3.02 PREPARATION

A. Selective Demolition Plan:
   1. Prepare and submit a comprehensive selective demolition plan for the Work including the following elements, at a minimum:
      a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
      b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
   2. Submit plan a minimum 4 weeks before demolition is scheduled to begin.

B. Pipe Abandonment Plan:
   1. Prepare and submit a comprehensive Pipe Abandonment Plan for the Work to demonstrate and verify with camera inspection that all solids have been removed and pipe is free of residual.
   2. At a minimum, define the following elements:
      a. Proposed sequence, methods, cleaning procedures, or demolition, removal, and disposal of contents of the piping.
      b. Method of verification of final pipe condition.
      c. Detailed drawings showing treatment of pipe ends**.**
   3. Submit plan a minimum 4 weeks before abandonment is scheduled to begin.

C. Protection:
   1. Erect weatherproof closures to protect the interior of facilities and elements or equipment that are not designed for exposure to the weather. Provide temporary heat, cooling, and humidity control as necessary to prevent damage to existing and new construction. Maintain existing exiting paths and/or provide new paths in compliance with Building Code requirements.
   2. Erect and maintain dustproof partitions as required to prevent spread of dust, to other parts of building. Maintain negative pressure in the area where the Work is being performed to prevent the accidental spread of dust and to minimize the spread of fumes related to the Work.
   3. Upon completion of Work, remove weatherproof closures and dustproof partitions, and repair damaged surfaces to match adjacent surfaces.
   4. Provide and maintain protective devices to prevent injury from falling objects.
   5. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
   6. Cause as little inconvenience to adjacent building areas as possible.
   7. Protect benchmarks and existing construction to remain from damage or displacement.
   8. Carefully remove designated materials and equipment to be salvaged by Owner or reinstalled.
   9. Store and protect materials and equipment to be reinstalled.

D. Layout:
   1. The limits of selective demolition are indicated on the Drawings. Confine demolition operations within the limits indicated on the Drawings.
   2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.
   3. Arrange for Engineer's inspection of the lay out extents.
   4. Do not begin demolition/removal operations until the lay out markings have been reviewed by the Engineer.

3.03 DEMOLITION

A. General:
   1. Perform demolition work in accordance with ANSI A10.6.
   2. Demolish designated portions of structures and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.
   3. Conduct demolition and removal work in a manner that will minimize dust and flying particles.
      a. Use water or dust palliative when necessary to prevent airborne dust.

b. Provide and maintain hoses and connections to water main or hydrant.

4. Demolish concrete and masonry in small sections. Perform demolition with small tools as much as possible. Blasting with explosive charges is not permitted.
5. Sawcut concrete to establish the edges of demolition, wherever possible.
   a. Do not use a concrete breaker within 6 inches of reinforcing or structural metals that are designated to remain.
   b. At edges that are not sawcut, remove the final 6 inches of material with a chipping hammer as defined herein. At surfaces where material is removed with a chipping hammer, follow with a heavy abrasive blast to remove all loose material and microcracking.
   c. Alternate techniques to remove concrete may be used if acceptable to the Engineer; however, techniques other than those deemed by ICRI Guideline No. 310.2R to provide a low risk of introducing microcracking will require a subsequent procedure to remove loose material.
   d. Provide final surface preparation for repairs as specified in technical specifications
6. At locations indicated on the Drawings that the existing reinforcing is to be preserved, remove concrete using methods that do not damage the reinforcing. Use one of the following techniques:
   a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
   b. Chipping hammer, as defined herein, followed by heavy abrasive blast to remove all loose material and microcracking at remaining surfaces impacted by the chipping hammer.
   c. Alternate methods may be used, only if acceptable to the Engineer.
   d. For all methods, provide a small completed area for Engineer's review and acceptance. If the proposed method, in the opinion of the Engineer, damages the reinforcing, revise the removal method to remove the concrete with a less aggressive technique to protect the reinforcing.
7. Remove materials carefully, to the extent indicated and as required.
   a. Provide neat and orderly junctions between existing and new materials.
   b. Use methods that terminate surfaces in straight lines at natural points of division.
8. Do not remove anything beyond the limits of Work indicated without prior written authorization of the Engineer. If in doubt about whether to remove an item, obtain written authorization of the Engineer prior to proceeding.
9. Perform work so as to provide the least interference and most protection to existing facilities to remain.
10. Assume possession of demolished materials, unless otherwise indicated on the Drawings or specified.
    a. Remove demolished materials from site at least weekly and dispose of in accordance with Laws and Regulations.
    b. Do not burn materials on site.

B. In-place Abandonment of Pipe:
   1. Abandoned pipe in-place as indicated on the Drawings.
   2. Clean buried or exposed solids service piping to a condition free of residual.
      a. Solids service piping includes: raw wastewater (RAW WW), primary sludge or scum (PS), mixed liquor (ML), return activated sludge (RAS), waste active sludge (WAS), surface waste activated sludge (SWAS), thickened waste activated sludge (TWAS), digested sludge (DS),

centrate, or other similar solids service subject to biological degradation, etc.

3. Provide closure of abandoned pipe cut ends as indicated on the Drawings using one of the following methods:
   a. Install cap.
   b. Install plug.
   c. Install drain valves, pressure relief valves, vents, etc.

C. Sizing of openings in existing concrete or masonry:
   1. Make openings large enough to permit final alignment of pipe and fittings without deflections, but without oversizing.
   2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
   3. If the Engineer deems the opening to be insufficient in size to accomplish these criteria, remove additional material using the procedures outlined in this Section.

D. Cutting openings in existing concrete or masonry:
   1. Do not allow saw cuts to extend beyond limits of openings.
   2. Create openings by the following method or other means acceptable to the Engineer that prevents over-cutting of member at corners:
      a. Core-drill through slab or wall at corners, being careful not to damage materials beyond the area to be removed.
      b. Saw cut completely through the member, between the core holes at the corners.
      c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth on both surfaces (when accessible).
         1) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
         2) Remove the remaining material with a chipping hammer.
      d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.
   3. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

E. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.

F. Remove trees and shrubs within marked areas; clear undergrowth and dead plant material as specified in Section 02300 - Earthwork.

G. Backfill open pits and holes caused by demolition as specified in Section 02300 - Earthwork.

H. Rough grade areas affected by demolition.

I. Remove demolished materials, tools, and equipment upon completion of demolition.

3.04 RESTORATION

A. General:
   1. Repair damage caused by demolition to a condition equal to those that existing prior to beginning of demolition.
      a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored with matching material. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface.
      b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
   2. The cost of repairs shall be at the Contractor's expense at no increase in the Contract Price.
   3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
   4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.
   5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
   6. Where changes of plane exceed 2 inches, request instructions for making transition.
   7. Trim and refinish existing doors as necessary to clear new floors.
   8. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
   9. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

B. Restore existing concrete reinforcement as follows:
   1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
   1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit, and fasteners with non-shrink grout and finish smooth.
   2. Remove concrete bases for equipment and supports by:
      a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface.
         1) Do not cut existing reinforcement on floors.
      b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
      c. Patch with non-shrink grout to match adjacent grade and finish.
   3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.

3.05 FIELD QUALITY CONTROL

A. Do not proceed with demolition without Engineer's inspection of lay out.

B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION

SECTION 01756

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for each Commissioning phase of, the Project equipment/system and/or facility.

1.02 DEFINITIONS

A. Commissioning - The process of planning, testing, and process start-up of the installation for compliance with contract requirements and demonstrating, through documented verification, that the project has successfully met the Contractual requirements. It includes training the Owner's staff to operate the facility.

B. Commissioning Phases - The work activities of facility commissioning are grouped into the phases defined in the table below.

Commissioning		
Planning Phase	**Testing and Training Phase**	**Process Start-Up Phase**
Owner Training Plan and Schedule	Source Testing	Process Start-up
Commissioning Schedule	Owner Training	Process Operational Period
Subsystem Testing Plan	Installation Testing	
	Functional Testing	
	Closeout Documentation	

C. Component - A basic building block of equipment, subsystems, and systems that requires installation or functional testing but does not have an electrical connection or internal electronics. (Examples: filter effluent piping and manual isolation valves).

D. Device - A basic building block of equipment, subsystems, and systems that requires installation or functional testing and does have an electrical connection or internal electronics. (Examples: filter level transmitter or water pump pressure transmitter).

E. Equipment - An assembly of component(s) and devices(s) that requires installation or functional testing. (Examples: Pump, motor, VFD, Ozone Generator, UV Disinfection System, etc.).

F. Facility - A grouping of process areas, systems, subsystems, equipment, components, and devices (Examples: treatment plant, pump station, etc.).

G. Functional Testing - Testing performed on a completed subsystem to demonstrate that equipment/system meets manufacturers' calibration and adjustment requirements and other requirements as specified. Functional testing includes

operating equipment/system manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).

H. Installation Testing - Testing to demonstrate that subsystem component (piping, power, networks, devices, etc.) is ready and meets the project requirements in advance of functional testing. Installation testing also includes manufacturers' certification of installation and other requirements as specified to prepare equipment/system for Functional Testing. Also referred to as Field Acceptance Testing.

I. Manufacturer's Certificate of Source Testing - When applicable, the form is used during Source Testing for the manufacturer to confirm that the applicable source tests have been performed and results conform to the Contract Documents. The form is provided at the end of this Section.

J. Manufacturer's Certificate of Installation and Functionality Compliance - The form is used during Installation Testing and Functional Testing. It is submitted at the end of Functional Testing to confirm that the equipment/system is installed in conformance with the Contract Documents and that it meets the Functional Testing requirements defined in the Contract Documents. The form is provided at the end of this Section.

K. Process Area - A grouping of systems, subsystems, equipment, components, and devices that divide a facility into functional areas. (Examples: Filter Process Area or Chemical Area).

L. Process Operational Period - A period of time after completion of the process start-up set aside for final Operational Testing to verify facility performance meets the Contract Document requirements. This period may specifically limit other construction activities.

M. Process Start-up Phase - Operating the facility to verify performance meets the Contract Document requirements.

N. Process Start-Up - Activities conducted after the testing and training phase that are necessary to place systems or process areas into operational service.

O. Product - A system, subsystem or component.

P. Subsystem - A building block of systems made up from a grouping of components, devices, and equipment that perform a definable function. (Examples: Filter No. 1 Backwash Subsystem, Sedimentation Basin No. 1 Hoseless Sludge Removal Subsystem).

Q. System - A grouping of subsystems, equipment, components, and devices that perform a definable function. (Examples: Filter No. 1, Sedimentation Basin).

1.03 SUBMITTALS

A. Qualifications:
   1. Commissioning Coordinator's qualifications.
   2. Manufacturer's representative's qualifications.

B. Schedules:
   1. Owner Training Plan Schedule.
   2. Commissioning Schedule.

C. Certificates:
   1. Manufacturer's Certificate of Source Testing.
   2. Manufacturer's Certificate of Installation and Functionality Compliance.

D. Reports:
   1. Test reports.

E. Plans:
   1. Owner Training Plan.
   2. Source Test Plan.
   3. Installation and Functional Testing Plan.
      a. Subsystem Testing Plans.
   4. Process Start-Up Plan.
      a. Process Operational Period.
   5. Final Operational Testing Plan.

F. Documentation:
   1. Preliminary documentation.
   2. Final documentation.
   3. Closeout documentation.

1.04 COMMISSIONING COORDINATOR (CC)

A. Designate and provide a CC for this project.
   1. Submit summary of the CC's qualifications within 30 days of NTP:
      a. Include description of previous experience as a CC on similar projects for the designated CC with a list of references including phone numbers for review and Owner approval.

B. CC responsibilities include the following:
   1. Lead efforts relating to Commissioning.
   2. Be thoroughly familiar with commissioning requirements in the Contract Documents.
   3. Be regularly engaged and experienced in all aspects of commissioning.
   4. Provide technical instruction for commissioning.
   5. Provide primary interface with Engineer and Owner for efforts relating to Commissioning of Project facilities.
   6. Coordinate training efforts.

1.05 SERVICES OF MANUFACTURER'S REPRESENTATIVES

A. Qualification of manufacturer's representative as specified in the Contract Documents technical sections include the following:
   1. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.

2. Competent, experienced technical representative of equipment/system manufacturer for assembly, installation, testing guidance, and training.
3. Additional qualifications may be specified in the individual sections.
4. Submit qualifications of the manufacturer's representative no later than 30 days in advance of required observations.
5. Representative subject to approval by Owner and Engineer.
6. No substitute representatives will be allowed until written approval by Owner and Engineer has been obtained.

B. Completion of manufacturer on-site services: Engineer approval required.

C. Manufacturer is responsible for determining the time required to perform the specified services.
1. Minimum times specified in the Contract Documents are estimates.
2. No additional costs associated with performing the required services will be approved.
3. Manufacturer required to schedule services in accordance with the Contractor's project schedule up to and including making multiple trips to project site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.

D. Manufacturer's on-site services as specified in the Contract Documents include the following:
1. Assistance during Commissioning Phase and Process Start-Up Phase.
2. Provide copies of manufacturer's representatives field notes and data to Engineer.
3. Other requirements as specified in the Contract Documents.

1.06 PLANNING PHASE

A. Overview of Planning Phase:
1. Define approach and timing for Commissioning.

B. Owner training plan and schedule:
1. Training outcomes:
a. Owner's operations, maintenance, and engineering staff have the information needed to safely operate, maintain, and repair the equipment/systems provided in the Contract Documents.
2. Training objectives:
a. To instruct personnel in the operation and maintenance of the equipment/system. Instruction shall include step-by-step troubleshooting procedures with all necessary test equipment/system.
b. To instruct personnel in the removal, inspection, and cleaning of equipment/system as needed.
c. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).
d. Provide supporting documentation, such as vendor operation and maintenance manuals.
3. Training schedule:
a. Schedule Owner's staff training within the constraints of their workloads. Those who will participate in this training have existing full-time work

assignments, and training is an additional assigned work task, therefore, scheduling is imperative. Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.

4. Training plan:
    a. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
    b. Conduct classroom training at location designated by Owner.
    c. Scope and sequence:
        1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
            a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
5. Training scheduling coordination:
    a. CC is responsible for the following:
        1) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).
    b. Complete Owner training no sooner than 15 calendar days prior to start of process start-up of each system.
6. Meetings:
    a. CC is responsible for setting commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
    b. CC shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 60 calendar days prior to commissioning of equipment/system.
    c. CC shall conduct commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.
        1) Frequency: Monthly minimum. Increase frequency as needed based on complexity and quantity of commissioning activities.
7. Submittals:
    a. Submit Training Plan Schedule 30 calendar days before the first scheduled training session, including but not limited to lesson plans, participant materials, instructor's resumes, and training delivery schedules.
    b. Submit training documentation including the following:
        1) Training plan:
            a) Training modules.
            b) Scope and sequence statement.
            c) Contact information for manufacturer's instructors including name, phone, and e-mail address.
            d) Instructor qualifications.
        2) Training program schedule:
            a) Format: Bar chart:
                (1) Additionally include in the Project Progress Schedule.
            b) Contents:
                (1) Training modules and classes.
8. Training sessions:
    a. Provide training sessions for equipment/system as specified in the individual equipment/system section.

C. Commissioning Schedule:
    1. Commissioning overview:
        a. Comply with Commissioning Roles and Responsibilities Matrix specified at the end of this Section.
    2. Submittal due date:
        a. Submit Commissioning Schedule not less than 30 calendar days prior to planned initial commissioning of each subsystem or system.
    3. Schedule requirements:
        a. Schedule durations and float for commissioning activities to ensure Work does not fall behind schedule due to complications or delays during commissioning.
        b. Time-scaled network diagram detailing the work to take place in the period between 60 calendar days prior to planned initial commissioning of equipment and systems, and prior to the date of Substantial Completion, together with supporting narrative.
        c. Provide detailed schedule of commissioning activities including durations and sequencing requirements.
            1) Identify the following activities:
                a) Testing and Training Phase:
                    (1) Source Testing.
                    (2) Owner Training.
                    (3) Installation Testing.
                    (4) Functional Testing.
                    (5) Closeout Documentation.
                b) Process Start-Up Phase:
                    (1) Process Start-Up.
                    (2) Process Operational Period.
        d. Schedule manufacturer's services to avoid conflict with other on-site testing or other manufacturers' on-site services.
        e. Verify that conditions necessary to allow successful testing have been met before scheduling services.

D. Installation and Functional Testing Plan:
    1. Submit Installation and Functional Testing Plan.
    2. Subsystem testing plans:
        a. Submit separate testing plans for each individual subsystem and system that include the following:
            1) Approach to testing including procedures, schedule, and recirculation requirements.
            2) Test objective: Demonstrate subsystem meets the design requirements as specified in the technical sections.
            3) Test descriptions, forms, temporary systems (pumps, piping, etc.), shutdown requirements for existing systems, test forms, test logs, witness forms, and checklists to be used to control and document the required tests.
            4) Test forms: Include, but not limited to, the following information:
                a) Tag and name of equipment/system to be tested.
                b) Test date.
                c) Names of persons conducting the test.
                d) Names of persons witnessing the test, where applicable.
                e) Test data.
                f) Applicable project requirements.

g) Check offs for each completed test or test step.
h) Place for signature of person conducting tests and for the witnessing person, as applicable.

5) Define start-up sequencing of unit processes:
a) Include testing of alarms, interlocks, permissives, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
b) Provide detailed test procedures setting forth step-by-step descriptions of the procedures for systematic testing of equipment/system.
c) Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration.
(1) Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
d) Demonstrate proper operation of each control loop function including mechanical, electrical, alarms, local and remote controls, instrumentation, and other equipment/system functions.
(1) Generate signals with test equipment/system to simulate operating conditions in each control mode.

b. Engineer approval of test plan is required prior to performing test.
1) Revise and update test plans based on review comments, actual progress, or to accommodate changes in the sequence of activities.
2) Submit test reports for each phase of testing for each equipment/system.
3) Engineer approval of preceding test reports is required prior to start of next test.
4) Tests will be rescheduled if test plan is not approved by the required deadline.
a) Contractor is responsible for any resulting delay.

c. Contractor is responsible to reproduce and distribute final test procedures.
1) Provide 3 copies for Engineer.

d. Tests may commence only after Engineer has received approved test plan copies.

e. Submittals:
1) Submit test plans not less than 15 calendar days prior to planned installation testing of subsystem or system.
2) Completed Manufacturer's Certificate of Installation and Functionality Compliance.
3) Test procedures and forms: Provide signed-off copy of test forms and test reports upon completion of the test.
4) Test reports:
a) Submit preliminary copies within 1 day after testing completion.
b) Submit final copies and report within 14 days after testing completion.

1.07 TESTING AND TRAINING PHASE

A. Overview of Testing and Training Phase:
   1. General:
      a. Include specified Source Testing, Owner Training, Installation Testing, Functional Testing, and Closeout Documentation required by this Section and the technical sections.
   2. Contractor responsibilities:
      a. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
      b. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.
      c. Acceptable tests: Demonstrate the equipment/system performance meets the requirements stated in the Contract Documents.
         1) When the equipment/system fails to meet the specified requirements, perform additional, more detailed, testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

B. Source testing:
   1. Also referred to as factory testing or factory acceptance testing (FAT).
   2. Test components, devices, and equipment/system for proper performance at point of manufacture or assembly as specified in the technical sections.
   3. Notify the Engineer in writing when the equipment/system is ready for source inspection and testing.
   4. Source Test Plan:
      a. As specified in this Section and other technical sections.
      b. Source testing requirements as specified in technical sections.
         1) Non-witnessed: Provide Manufacturer’s Certificate of Source Testing.
         2) Witnessed: 1 Owner's representative and/or 1 Engineer’s representative present during testing, unless otherwise specified, and provide Manufacturer’s Certificate of Source Testing.
      c. Prepared by Contractor as a result of discussions and planning emerging from regularly conducted commissioning meetings for source tests as specified in the Contract Documents.
      d. Provide the following items for each Source Test:
         1) Purpose and goals of the test.
         2) Identification of each item of equipment/system, including system designation, location, tag number, control loop identifier, etc.
         3) Description of the pass/fail criteria that will be used.
         4) Listing of pertinent reference documents (Contract Documents and industry standards or sections applicable to the testing).
         5) Complete description, including drawings or photographs, of test stands and/or test apparatus.
         6) Credentials of test personnel.
         7) Descriptions of test equipment to be used, product information, and all appropriate calibration records for the test equipment.
         8) Test set-up procedures.
         9) Detailed step-by-step test procedures.
            a) The level of detail shall be sufficient for any witness with a rudimentary technical aptitude to be able to follow the steps and

develop confidence that the tests were being performed as planned.
b) All steps are significant, and all steps shall be included in the procedures.
10) Sample data logs and data recording forms.
11) Sample computations or analyses with the results in the same format as the final report to demonstrate how data collected will be used to generate final results.
a) Complete disclosure of the calculation methodologies.
b) Include a sample for each type of computation required for the test and analysis of the results.
12) Detailed outline of the Source Test report.
13) Sample test reports.

e. Submit Source Test Plan and forms as specified in the technical sections.
1) Submit a copy of the Source Test Plan at least 21 days before any scheduled test date.
2) Engineer approval of Source Test Plan required prior to beginning source testing.
3) Schedule the testing after approval of the Source Test Plan submittal.

f. Indicate the desired dates for source inspection and testing.
1) Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

5. Test results:
a. Prepare and submit test results with collected data attached.

6. Contractor is responsible for costs associated with Owner's representatives and Engineer's representative witnessing Source Tests.
a. Include costs for at least the following:
1) Transportation:
a) Travel 1 day on commercial airline to site including air flight costs and $1,600 allowance per person per day.
b) Travel 1 day on commercial airline from site including air flight costs and $1,600 allowance per person per day.
c) Rental car from hotel to and from the test site.
2) Hotel costs at a facility with an American Automobile Association 4 star rating or equivalent for single occupancy room per person per day.
3) Meal allowance of $60 per person per day.
4) On-site time: 1 day at the site, unless specified otherwise, including $1,600 allowance per person per day.

b. If Source Test is not ready when the witnesses arrive or if the Source Test fails, the witnesses will return home with Contractor responsible for costs associated with the trip including costs described above. Contractor is responsible for rescheduling the Source Test and witnesses' costs associated with the second trip including costs described above.
c. Contractor is responsible for witnesses' costs associated with retests including costs described above.

7. Contractor is responsible for providing fuel, chemicals, and other consumables needed for Source Testing.

C. Owner training:
    1. Training instruction format:
        a. The training for operations and maintenance personnel shall be provided as one entity.
        b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
        c. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture.
        d. Visual aids and hands-on practice sessions must support training objectives.
        e. Lecturing should be less than 30 percent of class time.
        f. Conduct hands-on instruction according to the following descriptions:
            1) Present hands-on demonstrations of at least the following tasks:
                a) Proper start-up, shutdown, and normal and alternative operating strategies.
                b) Common corrective maintenance repairs for each group.
                c) Recommended procedures to check/test equipment/system following a corrective maintenance repair.
                d) Preventative maintenance points.
                e) Calibration, if applicable.
            2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
                a) Submit requests for supplemental assistance and facilities with the Contractor's proposed lesson plans.
            3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel.
    2. Class agenda:
        a. Include the following information in the agenda:
            1) Instructor name.
            2) Listing of subjects to be discussed.
            3) Time estimated for each subject.
            4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
            5) List of documentation to be used or provided to support training.
        b. Owner may request that particular subjects be emphasized and the agenda be adjusted to accommodate these requests.
        c. Distribute copies of the agenda to each student at the beginning of each training class.
    3. Number of students:
        a. Estimated maximum class size: 10 persons.
            1) Owner will determine the actual number of students.
            2) Engineer will provide an estimated headcount 1 week prior to the class, so that the instructor can provide the correct number of training aids for students.
    4. Instructor qualifications:
        a. Provide instructors completely knowledgeable in the equipment/system for which they are training.
        b. Provide instructors experienced in conducting classes.
        c. Provide instructor's technical preparation and instructional technology skills and experience.

d. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
e. If, in the opinion of the Owner, an appropriately knowledgeable person did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor.

5. Training aids:
   a. Instructors are encouraged to use audio-visual devices, P&IDs, models, charts, etc. to increase the transfer of knowledge.
   b. Instructors shall provide such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, etc. for each class.
   c. Instructor is responsible for confirming with Engineer and Owner in advance of each class that the classroom will be appropriate for the types of audiovisual equipment to be employed.
6. Classroom documentation:
   a. Trainees will keep training materials and documentation after the session.
   b. Operations and maintenance manuals, as specified in technical sections:
      1) Provide the quantity final Engineer-approved operations and maintenance manuals as specified in Section 01782 - Operation and Maintenance Data for use during the classroom instruction.
      2) Owner reserves the right to delay training for a particular equipment item if the operations and maintenance manuals for that equipment are incomplete, inaccurate, or otherwise unsuitable for use by the Owner's staff.
      3) No contract extensions or extra costs will be allowed for training delays due to operations and maintenance manual submittal delays.
   c. Provide supplemental documentation handouts to support instruction.
   d. Digitally record audio and video of each training session.
      1) Include classroom and field instruction with question and answering periods.
      2) Engineer approval required for producer of video materials from one of the following options:
         a) Qualified, professional video production company.
         b) Contractor demonstrates satisfactory skill.
      3) Record in digital format and recording shall become property of the Owner.
         a) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.
      4) Video files shall be file format and delivery medium as directed and approved by Owner.
      5) Provide 2 complete sets of video materials fully indexed and cataloged with printed labels stating session content and dates recorded.
      6) The Contractor shall provide a written release from all claims to the recorded training material produced, if required.
   e. Training modules:
      1) Provide a training module for each equipment category.
      2) Divide each training module's instructional content into discrete lesson plans.

f. Lesson plans:
    1) Provide performance-based learning objectives.
    2) State learning objectives in terms of what the trainees will be able to do at the end of the lesson.
    3) Define student conditions of performance and criteria for evaluating instructional success.
    4) Instruction lesson plan outlines for each trade.
        a) Provide specific components and procedures.
    5) Minimum requirements:
        a) Hands-on demonstrations planned for the instructions.
        b) Cross-reference training aids.
        c) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
        d) Attach handouts cross-referenced by section or topic in the lesson plan.
        e) Indicate duration of outlined training segments.
    6) Provide maintenance instruction lesson plans including mechanical, HVAC, instrumentation, and electrical aspects:
        a) Equipment operation:
            (1) Describe equipment's operating (process) function and system theory.
            (2) Describe equipment's fundamental operating principles and dynamics.
            (3) Identify equipment's mechanical, electrical, and electronic components and features.
            (4) Identify support equipment associated with the operation of subject equipment.
            (5) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
            (6) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
            (7) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.
        b) Detailed component description:
            (1) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).
                (a) Review preventive maintenance frequency and task analysis table.
            (2) Identify each component function and describe in detail.
            (3) Where applicable, group relative components into subsystems.
            (4) Identify and describe in detail equipment safety features, permissive and controls interlocks.
    7) Provide the following information in equipment troubleshooting lesson plans:
        a) Define recommended systematic troubleshooting procedures as they relate to specific craft problems.

b) Provide component specific troubleshooting checklists as they relate to specific craft problems.

8) Provide the following information in equipment Corrective Maintenance (CM) troubleshooting lesson:
   a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
   b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.
   c) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
   d) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
      (1) Additional demonstrations may be required by the Owner.
   e) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

7. Class logistics:
   a. Delivery time minimum: 2 hours.
   b. Delivery time maximum: 4 hours.
      1) Longer time requires Engineer approval.
   c. Class agenda:
      1) Refreshment break: One 10-minute break.
      2) Meal break: One 45-minute break, unless otherwise specified.
      3) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.
   d. Schedule specific sessions:
      1) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
      2) At the times requested by the Owner, within the period 7 a.m. to 7 p.m. Monday through Friday.
         a) Times scheduled will be at Owner's discretion.
      3) Owner approval and confirmation required for session schedules.
      4) Provide minimum of 1 session for each class unless otherwise noted.
         a) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.

8. Distribute Training Evaluation Form following each training session.
   a. Training Evaluation Form is included in this Section.
   b. Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
   c. Revise training sessions judged "Unsatisfactory" by a majority of attendees.
      1) Conduct training sessions again until a satisfactory rating is achieved at no additional cost to Owner.
9. Submittals:
   a. Prior to the training session:
      1) Instructor qualifications: Due 30 calendar days prior to initial training session.
      2) Training course materials: Due 14 calendar days prior to initial training session.

a) Training agenda, lesson plan, presentation, and handouts.
b) Other audio-visual aids utilized during each training course.
c) Format: 2 electronic copies and 3 hard copies organized in notebooks.

b. Post training session:
1) Training course materials: Due 14 calendar days after class completion.
a) Video recordings.
b) Class attendance sheet.
c) Training agenda, final lesson plan, presentation, and handouts.
d) Other audio-visual aids utilized during each training course.
e) Provide materials for all sessions of the class in a single transmittal.
f) Format: 2 electronic copies and 3 hard copies organized in notebooks.

D. Installation Testing:
1. Perform subsystem testing according to approved Subsystem Testing Plans.
2. Initiate the Manufacturer's Certificate of Installation and Functionality Compliance for all equipment.
a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment meets the following requirements:
1) Has been properly installed, adjusted, aligned, and lubricated.
2) Is free of any stresses imposed by connecting piping or anchor bolts.
3) Is able to be operated as necessary for Functional Testing.
c. Form shall be submitted after completion of Functional Testing, as specified in this Section.
3. Coordinate Installation Testing with restrictions and requirements as specified in Section 01140 - Work Restrictions.
4. Perform coating holiday testing as specified in Section 09960 - High-Performance Coatings.
5. Perform pressure and leakage testing as specified in individual component Sections and Section 15956 - Piping Systems Testing.
6. Perform mechanical equipment Installation Testing: As specified below and in individual equipment sections, such as Section 15050 - Common Work Results for Mechanical Equipment and 15958 - Mechanical Equipment Testing
a. Remove rust preventatives and oils applied to protect equipment during construction.
b. Flush lubrication systems and dispose of flushing oils.
1) Recharge lubrication system with lubricant recommended by manufacturer.
c. Flush fuel system and provide fuel for testing and start-up.
d. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
e. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
f. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
g. Perform cold alignment and hot alignment to manufacturer's tolerances.
h. Adjust V-belt tension and variable pitch sheaves.

i. Inspect hand and motorized valves for proper adjustment.
    1) Tighten packing glands to ensure no leakage, but permit valve stems to rotate without galling.
    2) Verify valve seats are positioned for proper flow direction.
j. Tighten leaking flanges or replace flange gasket.
    1) Inspect screwed joints for leakage.
k. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

E. Functional Testing:
1. Complete valve and gate labeling as specified in Section 15076 - Pipe Identification prior to the start of Functional Testing.
2. Perform subsystem testing according to approved Subsystem Testing Plan.
3. Notify the Engineer 5 days prior to when the Work is ready for Functional Testing.
    a. Perform testing in the presence of the Engineer.
4. Determine Functional Testing durations with Owner's input.
    a. Durations will vary depending on the availability of water for testing.
    b. Target minimum Functional Test duration: 8 hours.
        1) Identify equipment/system that cannot be tested for a minimum of 8 hours as specified in technical sections.
5. Perform Functional Testing as specified in technical sections.
    a. Perform Functional Testing in addition to the other tests specified in the technical sections.
    b. Perform Functional Testing to demonstrate that the component equipment functions as an entire system in accordance with the design requirements.
    c. Perform Functional Testing to demonstrate that the unit process has operated in a manner necessary to demonstrate equipment/system functions manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).
    d. Perform testing with Contractor-provided water.
    e. Repair or replace parts that operate improperly and retest.
    f. Submit testing reports as specified in the technical sections to the Owner and Engineer for approval of Functional Testing reports.
6. Provide completed Manufacturer's Certificate of Installation and Functionality Compliance forms for all equipment.
    a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
    b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment/system meets the following requirements:
        1) Is suitable for satisfactory full-time operation under full-load conditions.
        2) Operates within the allowable limits for vibration and noise.
        3) Electrical and instrumentation requirements:
            a) Electrical equipment, instrumentation, and control panels are properly installed, calibrated, and functioning.
            b) Electrical Installation Testing is complete, and test results have been approved by the Engineer.
                (1) Noted deficiencies have been corrected.
                (2) Relays, circuit breakers, and other protective devices are set.

c) Control logic for start-up, shutdown, sequencing, interlocks, control, and emergency shutdown has been tested and is properly functioning.
d) Motor control is calibrated and tested.

F. Closeout documentation submittals:
1. Provide records generated during Commissioning Phase of Project including but not limited to:
a. Training documentation.
b. Manufacturer's Certificate of Source Testing.
c. Manufacturer's Certificate of Installation and Functionality Compliance.
d. Daily logs of equipment/system testing identifying tests conducted and outcome.
e. Test forms and documentation.
f. Functional Testing results.
g. Logs of time spent by manufacturer's representatives performing services on the job site.
h. Equipment lubrication records.
i. Electrical phase, voltage, and amperage measurements.
j. Insulation resistance measurements.
k. Bearing temperature measurements.
l. Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints. Format: 2 electronic copies and 3 hard copies organized in notebooks.
m. Due date: Within 14 calendar days of Substantial Completion.

1.08 PROCESS START-UP PHASE

A. Overview of Process Start-Up Phase:
1. Operating the facility to verify performance meets the Contract Document requirements.

B. Process Start-Up:
1. Perform process start-up in the presence of the Engineer.
2. Pre-start-up activities and submittals:
a. Commissioning Documentation and Data Review.
b. Start-Up Go/No-Go Decision Criteria.
c. Building and Fire Inspection Compliance Check.
d. Process Start-Up Sequence Review.
e. Process Start-Up plan for review by Engineer not less than 30 calendar days prior to planned commencement of process start-up activities.
1) Include the following:
a) Pre-start-up activities.
b) Process Start-Up.
c) Process Operational Period.
f. Description of Temporary Testing Arrangement, if applicable.
g. Final Process Start-Up Forms and Documentations.
h. Final Operational Testing Plan.
3. Control loop tuning.
a. Perform control loop tuning during system testing with water to the extent possible.
4. Process area start-ups.

a. Process start-up individual process areas comprised of multiple interdependent systems where possible and beneficial to reduce complexity and risk of complete facility testing.
b. Process area test flows may be limited by upstream and downstream process constraints (i.e., tank and basin volumes) and/or localized recirculation capabilities.

5. Facility-wide process start-up.
   a. Upon approved completion of pre-start-up activities, perform entire facility process start-up.
      1) Complete control loop tuning during this phase of process start-up.
      2) Continue process start-up operations until facility meets or exceeds the Contract requirements.
   b. Remaining equipment/system tests:
      1) Conduct remaining specified equipment/system performance tests that could not be performed during the Testing and Training Phase due to inter-system and/or treatment process dependencies.

C. Process Operational Period:
   1. Prior to beginning the Process Operational Period:
      a. Conformance with treatment standards is required prior to Operational Testing, if applicable.
      b. Correct any outstanding punch list items prior to the Operational Testing.
   2. Duration: 7 calendar days.
   3. Engineer will be present for process operational period unless such presence is expressly waived in writing.
   4. Prove facility conformance with Contract Document requirements.
   5. Contractor to provide:
      a. Specified start-up materials and operating supplies.
      b. Necessary craft of labor assistance, in the event of an emergency equipment failure requiring immediate attention (emergency is defined as a failure of function which precludes the further operation of a critical segment of or the whole of the Work) with a response time of not more than 4 hours from the time of notification.
      c. Manufacturer's authorized representative to supervise placing equipment/systems in operation and provide guidance during Operational Testing per applicable section.
      d. Necessary manufacturer's representatives and operating supplies for retesting systems that fail to pass the initial Operational Testing due to deficiencies in products of workmanship at no additional cost to the Owner.
      e. List of 24-hour "on-call" representative supervisory persons who will monitor the Operational Testing and serve as liaison for the Engineer and Owner.
   6. Owner will provide:
      a. Operations personnel for duration of test.
   7. Prior to date of Substantial Completion of Installation, the Contractor's CC shall oversee Process Operational Period.
      a. Owner staff will operate the completed Project construction.
      b. Entire system shall continuously meet performance requirements and shall operate without fault, failure, or defect for a continuous period.
      c. Individual equipment/system failures that are corrected within 24 hours and do not prevent the entire project from continuously satisfying the

established operational requirements shall not require the consecutive day test to be restarted unless the failure recurs.

d. Restart the consecutive test period for any of the following conditions:
    1) Any failure of the complete Project construction to meet operational requirements.
    2) When malfunctions or deficiencies cause shutdown or partial operation of the facility, or results in failure of the complete Project construction to meet operational requirements.
    3) Any individual equipment/system failure that meets any of the following conditions:
        a) Requires more than 24 hours to correct, unless otherwise specified in Section 17950 - Testing, Calibration, and Commissioning.
        b) Recurs within the 24-hour correction period requiring further correction.
    4) Immediately correct defects in material, workmanship, or equipment/system which became evident during Operational Testing.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

_____

_____

_____

_____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract Documents, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

_____
(Authorized Signature)

If applicable, Witness Name *(print)*: _____

_____
(Witness Signature)

MANUFACTURER'S CERTIFICATE OF
INSTALLATION AND FUNCTIONALITY COMPLIANCE

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the installation and function of the above-referenced equipment/system as defined in the Contract Documents. The above-referenced equipment/system has been: (Check Applicable)

- ☐ Installed in accordance with manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical/instrumentation and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functionally tested.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements.

NOTES:
Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

COMMISSIONING

TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: _____

VENDOR/MANUFACTURER: _____

DATE: _____ NAME OF REPRESENTATIVE: _____

1.	Was representative prepared?	Acceptable	Unacceptable	or	N/A
2.	Was an overview description presented?	Acceptable	Unacceptable	or	N/A
3.	Were specific details presented for system components?	Acceptable	Unacceptable	or	N/A
4.	Were alarm and shutdown conditions clearly presented?	Acceptable	Unacceptable	or	N/A
5.	Were step-by-step procedures for starting, stopping, and troubleshooting presented?	Acceptable	Unacceptable	or	N/A
6.	Were routine/preventative maintenance items clearly identified?	Acceptable	Unacceptable	or	N/A
7.	Was the lubrication schedule (if any) discussed?	Acceptable	Unacceptable	or	N/A
8.	Was the representative able to answer all questions?	Acceptable	Unacceptable	or	N/A
9.	Did the representative agree to research and answer unanswered questions?	Acceptable	Unacceptable	or	N/A

10. Comments: _____

_____

_____

_____

11. Overall Rating: Satisfactory Unsatisfactory

Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Testing and Training Phase				
Source Testing				
1	Source Testing	Witness	Lead	Witness, Review
Installation Testing				
2	Electrical Conductor Testing	No Action	Lead	Witness
3	Electrical Field Acceptance Tests	No Action	Lead	Witness
4	Instrument Field Calibration	No Action	Lead	Witness
5	Network Installation Testing	Witness	Lead	Witness
6	Loop Testing	Witness	Lead	Witness
7	Pressure Testing	No Action	Lead	Witness
8	Leak Testing	No Action	Lead	Witness
9	Holiday Testing	No Action	Lead	Witness
10	HVAC Testing	No Action	Lead	Witness
11	Motor Electrical Testing	No Action	Lead	Witness
Functional Testing				
12	Network Operational Testing	Witness	Lead	Review
13	Preliminary Run Testing Local/Manual Control	Witness	Lead	Review
14	PCIS Functional Demonstration Testing - Local/Auto Control Testing - Remote/Manual Contact Testing - Alarm Testing - Control Loop Testing	No Action	Lead	Review
15	Subsystem Start-Up and Testing	Witness	Lead	Review
16	Equipment/System Start-Up and Testing	Witness	Lead	Review
17	HVAC Start-Up and Testing	Witness	Lead	Review
18	Corrosion Control Start-Up and Testing	Witness	Lead	Review
19	Wide Area Network Communications Testing	Support	Lead	Witness
20	Manufacturer's Certificate of Installation and Functionality Compliance	No Action	Lead	Witness, Review
Clean Water Facility Testing				
21	Test Water Management Plan Finalization	Support	Lead	Review
22	Clean Water Facility Testing	Witness	Lead	Witness, Review
Process Start-Up Phase				
Process Start-Up				
23	Commissioning Documentation and Data Review	Review	Support	Lead
24	Start-Up Go/No-Go Decision Criteria	Lead	Support	Review
25	Building and Fire Inspection Compliance Check	No Action	Lead	Witness

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Testing and Training Phase				
26	HVAC Functionality Check	No Action	Lead	Witness
27	Start-Up Sequence Review	Support	Lead	Review
28	Temporary Testing Arrangement Finalization	Support	Lead	Support
29	Start-Up Forms Finalization	Support	Lead	Support
30	Operation Testing Plan Finalization	Review	Support	Lead
31	Test Water Management Plan Finalization	Support	Lead	Review
32	System Testing	Support	Lead	Witness
33	Control Loop Tuning	Support	Lead	Witness
34	Process Area Start-Ups	Support	Lead	Witness
35	Facility-Wide Start-Up	Support	Lead	Witness
36	Process Control Systems Testing	Support	Lead	Witness
38	HVAC Final Testing, Adjust, and Balancing	Witness	Lead	Witness, Review
Process Operational Period				
39	Operational Testing	Support	Lead	Witness, Review
40	Final Testing Reports	Support	Lead	Review
41	Water Quality Testing and Documentation	Support	Lead	Review
Instrumentation and Controls Reliability Phase				
Instrumentation and Controls Reliability Period				
42	As specified in Section 17950 - Testing, Calibration, and Commissioning			

Legend:
Lead: Primarily responsible for organization, coordination, and execution of task work product or result.
Support: Assist the lead with organization, coordination, and execution of task work product or result.
Witness: Observe and document completion of task work product or result.
Review: As necessary to accept task work product result.
No Action: Limited or no involvement.

SECTION 01759

WATER LEAKAGE TEST FOR CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrostatic leakage test for concrete water-holding structures.

1.02 REFERENCES

A. Abbreviations and acronyms.

B. Definitions.
   1. Damp spots: Surfaces where visible moisture can be picked up by a dry hand.
   2. Containment structure, lined: Liquid-containing structure with barrier coating or membrane applied to the inside surfaces to prevent leaking of contents to the outside.
   3. Containment structure, unlined: Liquid containing structure where only the concrete structure itself is used to prevent leaking of contents to the outside.

C. Reference standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination.

B. Pre-installation meetings.

C. Sequencing.

D. Scheduling.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings:
   1. Description and details of each evaporation/precipitation-measuring device anticipated for use during the test.

C. Samples.

D. Certificates.

E. Delegated design submittals.

F. Tests and evaluation reports:
   1. Results of water leakage test for each structure and for each portion of a structure designated for testing.

G. Manufacturer instructions.

H. Source quality control submittals.

I. Field/site quality control submittals.

J. Manufacturer reports.

K. Sustainable design submittals.

L. Special procedure submittals:
   1. Testing plan for each structure, or portion thereof, required to be tested.
      a. Describe methods of obtaining water for testing and of releasing water for disposal, including provisions for dechlorination if required.
      b. Include plans showing locations where measurements will be made and locations of evaporation/precipitation-measuring device.
      c. Indicate plans for filling and draining structure(s).
      d. Include schedule showing duration of test for each structure or cell to be tested, date and time for start of each test, dates and times of observations and measurements during the test, dates and times for closeout of testing procedures, and date for submittal of final results.
   2. Proposed procedures and products for repair of leaks.

M. Qualifications statements.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Test structures and portions of structures listed in the following paragraphs for water leakage.
   1. Unless otherwise specified, the Contractor shall:
      a. Obtain all required permits for discharging testing water.
      b. Provide dechlorination of such water if required by the permits.
      c. Prepare and fill the structures.
      d. Provide access and equipment required for testing and for recording test results.
      e. Take measurements and make observations required for testing.
   2. At all times during testing, the Engineer shall have access to observe measurements by others or to make independent measurements.

B. Test the following concrete structures for water leakage:
   1. Weir Vault.

C. Required preparation for testing is designated in this Section. Waiver of, or failure to complete preparations shall not change the testing criteria or approval criteria for the areas tested.

D. Retest structures and portions of structures until the evaluation criteria are satisfied.

3.02 TEST WATER SOURCE AND DISPOSAL

A. Water used for the first filling of the structures will be furnished by Owner.

B. In the event that retesting is required, Contractor shall bear the cost of refilling the structures for subsequent tests.

C. After leakage testing is complete, Contractor shall dispose of water to either the existing clarifier, reclaim ponds, or sludge lagoons.

3.03 PREPARATION

A. For each structure to be tested, prepare and submit a plan showing schedule and sequence of activities, method of filling, and methods of disposing of test water.

B. Sequencing requirements:
   1. Complete construction of concrete structure and cure concrete to obtain minimum specified 28-day compressive strength as specified in Section 03300 - Cast-in-Place Concrete.
      a. Do not begin tests until all portions of structure are complete and have reached their minimum specified 28-day compressive strength.
      b. Do not begin tests until at least 14 days have passed since completion of the last concrete placement.
   2. Complete tests before:
      a. Covering any surface of the structure with materials that might mask the location of leaks or obscure damp concrete surfaces. Such coverings include, but are not limited to basin bottom grout, masonry veneer, stucco, plaster, and other coatings.
      b. Installation of equipment, unless otherwise approved by the Engineer.
      c. Backfilling structures to elevations above the limits indicated in the following paragraphs.
   3. Liners and coatings:
      a. Install liners that are mechanically locked to the concrete surface during placement of plastic concrete and before leakage testing.
         1) Examine liners for pinholes, tears, and partially fused splices, complete all required liner integrity testing, and make required repairs before commencing leakage testing.
      b. Unless otherwise specified, do not install surface-applied protective or decorative coatings and linings until leakage tests have been completed.

C. Weather requirements:
   1. Tests on structures with tops open to the atmosphere shall not be scheduled for periods when the 10-day weather forecast indicates a substantial change in weather patterns.
   2. Measurements of water surface levels in the structure shall not be scheduled for periods when the weather forecast indicates a difference of more than 35 degrees Fahrenheit between the ambient temperature readings at the times of initial and final measurements.
   3. Tests shall not be scheduled for periods when the 10-day weather forecast indicates that the water surface may freeze before the test is complete.

D. Clean interior of structure:
   1. Remove dirt, contaminants, and construction debris.
   2. Flush floors and sumps to provide clean surfaces.
   3. Remove standing water that would interfere with examination of surfaces, cracks, or joints.

E. Observe the structure, or portions of the structure being tested, for potential leak locations:
   1. Give particular attention to cracks, open joints, voids, and honeycombed and repaired surfaces.
   2. Visually observe openings, fitting, and pipe penetrations in the structure at both faces, if possible.
   3. Repair potential leak locations in accordance with these Specifications and as approved by the Engineer.
   4. Backfill excavations to the top of the structure foundation. Do not place backfill against water-bearing walls or over footings unless approved in advance by the Engineer.
      a. If requesting backfilling of walls before testing, include a description of methods that will be used to detect leakage in the backfilled areas.
      b. Engineer's approval of backfilling before testing shall not relieve Contractor of the responsibility to conduct leakage tests, to satisfy the leakage acceptance criteria for the structure, or to repair leaking portions of the structure, including those portions below or behind the backfill.
   5. See Drawings and Section 02300 - Earthwork for requirements to provide wall stability before backfilling.

F. Inlets to/outlets from the structure:
   1. Make inlets to and outlets from the structure watertight.
      a. Include valves; stop, sluice, and slide gates; and temporary bulkheads as required.
      b. Inlets and outlets not required to be operable may be temporarily sealed before testing of the compartments to which they open.
      c. Secure inlets used to fill the structure for testing to ensure that no water is entering or leaving the structure once it has been filled to the test level.
   2. Adjustments to measured leakage at inlets and outlets based on manufacturer's or Contractor's estimates will not be allowed.
      a. Adjustments to measured leakage may be permitted by the Engineer, and, at his/her discretion, only when the Contractor makes specific measurements of leakage at each individual inlet and outlet using methods approved by the Engineer.

3.04 HYDROSTATIC LEAKAGE TEST FOR OPEN OR COVERED CONTAINMENT STRUCTURES ("HST-100")

A. Isolate sections of water-holding structures that can be isolated in actual operation. Fill and test sections for leakage separately.
   1. Fill structures and sections of structures scheduled for testing to 1 inch below any fixed overflow level in covered structures or 4 inches below the overflow level of open structures.

B. HST-100 testing includes 2 parts, “Qualitative Testing,” and “Quantitative Testing,” as described in the following paragraphs:
   1. HST-100, Part 1 - Qualitative Testing:
      a. During the first 24 hours after structures are filled, examine exposed concrete surfaces for damp spots or flowing water.
         1) Make observations in early morning, at midday, and in late afternoon.
         2) Continue observations through the duration of the Quantitative Testing period.
         3) Pay particular attention to conditions at joints, honeycombed areas, cracks, and repaired portions of the structure.
      b. Evaluation criteria:
         1) The structure shall be considered to have failed these Qualitative Testing requirements if any of the following conditions are observed.
            a) Water droplets or moist areas on an outside surface that could only have originated inside the structure.
            b) Water is flowing or seeping from joints, cracks, or surfaces.
               (1) Exception: Dampness or wetness on top of a footing, in the absence of flowing water, shall not be considered as failure to meet this criterion.
            c) Moisture can be transferred to a dry hand from the outside surfaces of the filled area.
      c. Repairs and retesting:
         1) Where damp spots or flowing water as described in the preceding paragraphs are observed, mark locations, provide repairs, and retest the structure as specified in subsequent paragraphs.
   2. HST-100 - Part 2: Quantitative Testing:
      a. If approved by the Engineer, Quantitative Testing may begin before repairs are made to areas failing Part 1 of this test; however:
         1) Adjustments to volume loss calculations of Quantitative Testing based on observed leakage will not be permitted.
         2) All defects identified for repair during Qualitative Testing shall be repaired to the satisfaction of the Engineer before approval of the structure.
      b. Report the results of Quantitative Testing on “Leakage Test Report” included as Figure A at the end of this Section, or similar form prepared by the Contractor and containing at least the information included in Figure A.
      c. Unlined concrete structures:
         1) Fill to the designated water surface elevation. Maintain that level for at least 72 hours before recording initial water levels for leakage test.
         2) Duration of test:
            a) Weir Vault Structure: 24 hours.
            b) Sludge Return Manholes: 12 hours.
      d. Lined concrete structures and secondary containment areas:
         1) Fill to the designated water surface elevation. Recording of water levels for leakage tests may begin as soon as the designated water surface level is reached and the water surface is calm.
         2) Duration of test: 72 hours (3 days).
      e. Measurements: Water level:
         1) Record water levels at 24-hour intervals for the full duration of the test period.

2) Measure water levels at not less than 2 locations on opposite ends of the structure, and preferably at 4 locations spaced equally around the structure. Mark locations on the structure and take measurements at the same locations throughout the duration of the test.
3) Measure, to an accuracy of 1/16 inch, the vertical distance to the water surface from a fixed point on the structure above.

f. Measurements: Temperatures:
1) As part of the first and last sets of level measurements, record water temperature at a depth of 18 inches below the water surface. Measure temperature at the same locations where level measurements are taken.
2) Record ambient temperature at the time of each water level measurement.

g. Measurements: Evaporation and precipitation:
1) Measure evaporation and precipitation by floating pans inside the structures during testing.
a) For uncovered structures, measure both evaporation and precipitation.
b) For covered structures that are well ventilated, measure evaporation.
2) Measure using specially constructed clear containers:
a) Provide clear plastic, calibrated, open-top containers not less than 18 inches in diameter and 18-inches deep.
b) Partially fill containers with water and float inside the structure. Make provisions to hold containers in place at each measurement location, but away from structure walls and items passing overhead, such as beams or pipes.
c) Measure initial depth of water in each device. Measure changes in water level in each device at the same time measurements of the water level inside the structure are taken.

h. Restart of test:
1) The Engineer may order a restart of the test when, in the Engineer's opinion, measurements have become unreliable due to unusual precipitation or other factors.
2) If measurements or observed leakage during the testing period indicate that the allowable leakage requirements will be exceeded, the test may be terminated before completion of the full test period. Take appropriate actions to correct problems before restarting the test.

i. Calculations of leakage test results:
1) For each section of the structure tested, use water surface level records to calculate average loss of volume per 24-hour interval.
a) For each 24-hour interval during the test, calculate the average of all measured drops in water level around the structure.
b) Use the average drop thus determined to calculate an average loss of volume for each 24-hour interval.
2) Adjustments to leakage calculations:
a) For uncovered basins, calculations shall be corrected for precipitation added to the structure.
b) Calculations may be corrected for evaporation and water temperature.

j. Evaluation criteria:
1) Unless otherwise specified, the average loss of volume during any 24-hour interval shall not exceed the limits shown in Table A.

Table - Loss of Volume Criteria for Leakage Tests	
Structure Type	**Maximum Loss of Water Volume**
• Structure fully lined prior to leakage test. • Secondary containment areas.	No measurable loss over 72-hour test period.
• Structure with monolithically placed membrane floor slab.	0.0125 percent of volume per 24-hour period.
• Concrete paved canals, drying beds, lagoons, and similar structures.	0.100 percent of volume per 24-hour period.
• Other containment structures.	0.050 percent of volume per 24-hour period.

k. Repairs and retesting:
1) Structures and portions of structures that have satisfied the qualitative requirements of HST-100 but have failed to satisfy the quantitative requirements of HST-100 may be immediately retested for volume loss.
a) If the structure fails the second test for volume loss, the structure shall be drained, and the Contractor shall observe the interior for probable areas of leakage.
b) The structure shall not be retested until repairs to the probable areas of leakage are complete.

3.05 REPAIRS FOR RETESTING

A. Locations showing damp spots or flowing water:
1. Mark locations of visible leaks and damp spots.
2. Drain structures for repair.
3. Repair defects causing damp spots and flowing water using methods specified in Section 03300 - Cast-in-Place Concrete and approved by the Engineer.
a. Repair both interior and exterior surfaces and make structures watertight.
b. Submit proposed repair products and procedures for Engineer’s review.
c. Refill structures for retesting.
4. Repeat filling, observations, and repairs until no leaks or damp spots appear.

B. Structures for which loss of water volume loss exceeds the limits specified after adjustments for evaporation, and precipitation:
1. Determine cause of volume loss.
2. Drain structures of water.
3. Repair defects causing loss of water volume using methods specified in Section 03300 - Cast-in-Place Concrete and approved by the Engineer.
a. Submit proposed repair products and procedures for Engineer’s review.
4. Refill water-holding structures.
5. Repeat testing and repairs until volume loss does not exceed specified limits.

END OF SECTION

FIGURE A

WATERTIGHTNESS TEST REPORT

PROJECT:		SUBMITTED BY:	
STRUCTURE:		WITNESSED BY:	
AREA:		TEST DATES:	
TEST DURATION:		TEST DURATION:	

Surface area of structure tested:		(square feet)
Volume of structure tested:		(cubic feet)
Volume of structure tested:		(gallons)
Measured loss through gates, etc.:		(gallons / day)
Allowable loss of water volume:		(per day)
Allowable loss of water volume:		(% in 24 hours)
Allowable measured loss over test duration (inches):		
Measured loss of water:		(gallons / day - From E below)
Measured loss of water volume (%):		(in 24 hours - From E below)

Water Temperature: Start of test: °F End of test: °F

			Water Surface Elevation (top of structure to top of water)				
			Location #1	Location #2	Location #3	Location #4	Initials**
Day	Date	Time	(inches)	(inches)	(inches)	(inches)	
1							
2							
3							
4							
5							
Changes in Level:							

A. Average change in level (feet): _____ (Average of total charges for all locations)

B. Correction for precipitation: _____ (Measured from pan)

C. Correction for evaporation: _____ (Measured from pan)

D. Corrected change in level (CL): _____

E. Total days tested: _____

F. Average measured % water loss in 24 hours: _____ = $\frac{(CL) \times (\text{surface area}) \times 100}{(\text{initial water volume}) \times (\text{number of test days})}$

Notes and field observations**

** Place date and initials at the beginning of each entry

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Contract closeout requirements including:
   1. Final cleaning.
   2. Waste disposal.
   3. Touch-up and repair.
   4. Disinfection of systems.
   5. Preparation and submittal of closeout documents.
   6. Certificate of Substantial Completion.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Substantial Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

J. Polish waxed woodwork and finish hardware.

K. Wash tile.

L. Wax and buff hard floors, as applicable.

M. Wash and polish glass, inside and outside.

N. Wash and shine mirrors.

O. Polish glossy surfaces to clear shine.

P. Vacuum carpeted and soft surfaces.

Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.

R. Clean ducts, blowers, and coils when units were operated without filters during construction.

S. Clean light fixtures and replace burned-out or dim lamps.

T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from Owner of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to Final Completion of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Substantial Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF PLANT FACILITIES

A. Clean channels, pipe, basins, reservoirs, and tanks before running of 7-day test, or before facility goes on stream when 7-day test is not required.

B. Wash, wherever practicable, or broom sweep channels, pipe, basins, reservoirs, and tanks.

C. Disinfect piping intended to carry potable water as follows or in accordance with AWWA Standards.

D. Provide ample sampling outlets in pipe for testing.

E. Fill pipe and other plant facilities with chlorine solution of sufficient strength to retain residual of not less than 10 parts per million at end of 24 hours.

F. When reservoirs and basins are too large to be economically disinfected by filling with chlorine solution, spray reservoirs and basins with solution containing 100 parts per million of chlorine.

G. After disinfection, rinse entire potable water system with potable water sufficient to reduce chlorine residual to not more than 0.6 parts per million throughout system before system is put into service.

1.07 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals before Substantial Completion:
   1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.
   6. Keys and Keying Schedule.
   7. Completed contract requirements for commissioning and process start-up.

B. Submit following Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punch list of items have been completed and Engineer and Owner are satisfied that all deficiencies are corrected.
   2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
   3. Release of claims as outlined in Conditions of the Contract.
   4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
   5. Final statement of accounting.

1.08 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

A. Submit the following:
   1. Certificate of Occupancy.
   2. Certificates of Inspection.

1.09 PROJECT RECORD DOCUMENTS

A. Maintain at Project site, available to Owner and Engineer, 1 copy of the Contract Documents, shop drawings, and other submittals in good order:
   1. Mark and record field changes and detailed information contained in submittals and change orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.

4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
5. Provide schedules, lists, layout drawings, and wiring diagrams.

B. Make annotations in electronic format. Maintain documents separate from those used for construction:
1. Label documents "RECORD DOCUMENTS."

C. Keep documents current:
1. Record required information at the time the material and equipment is installed and before permanently concealing.
2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for Engineer’s recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01321 - Schedules and Reports.

1.10 MAINTENANCE SERVICE

A. Maintenance service as specified in technical specifications.

1.11 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.12 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
1. Work has been completed in accordance with the Contract Document:
2. Punch list items have been completed or corrected.
3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the Engineer that the Work is complete.
3. Engineer shall re-inspect the Work.

1.13 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount.
   1. The original Contract amount.
   2. Additions and deductions resulting from:
      a. Change Orders.
      b. Units installed and unit prices.
      c. Setoffs for uncorrected or incomplete Work.
      d. Setoffs for liquidated damages.
      e. Setoffs for reinspection payments.
      f. Extended engineering and/or inspection services and inspection overtime.
      g. Excessive shop drawings review cost by the Engineer.
      h. Other adjustments.
   3. Total Contract amount, as adjusted.
   4. Previous payments.
   5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.14 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01782

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation and submittal of Operation and Maintenance Manuals.

1.02 GENERAL

A. Submit Operation and Maintenance Manuals as specified in technical sections.

B. Make approved manuals available at project site for use by construction personnel and Owner.

1.03 SUBMITTALS

A. Draft Operation and Maintenance Manuals:
   1. Submit prior to shipment of equipment or system to site.
   2. Shipment will be considered incomplete without the draft Operation and Maintenance Manuals.
   3. Quantity:
      a. Hard copy: 2 sets.
      b. Electronic: 1 PDF submitted electronically.

B. Final Operation and Maintenance Manuals:
   1. Make additions and revisions in accordance with Owner's and Engineer's review comments on draft manuals.
   2. Submit approved Operation and Maintenance Manuals at least 30 days prior to Functional Testing and at least 60 days prior to Owner Training.
   3. Quantity:
      a. Hard copy: 2 sets.
      b. Electronic: 1 PDF submitted electronically.

1.04 PREPARATION

A. General requirements:
   1. Provide dimensions in English units.
   2. Assemble material, where possible, in the same order within each volume.
   3. Reduce drawings and diagrams to 8 1/2 by 11-inch size, if possible unless otherwise specified.
   4. Complete forms on computer, handwriting not acceptable.
   5. Delete items or options not provided in the supplied equipment or system.
   6. Provide package control system annotated ladder logic for PLC, if applicable.

B. Hard copy requirements:
   1. Binders: 3-ring with rigid covers.
      a. Break into separate binders as needed to accommodate large size.

2. Utilize numbered tab sheets to organize information.
3. Provide original and clear text on reproducible non-colored paper, 8 1/2 by 11-inch size, 24-pound paper.
4. Drawings larger than 8 1/2 by 11 inch:
    a. Fold drawings separately and place in envelope bound into the manual.
    b. Label each drawing envelope on the outside regarding contents.

C. Electronic requirements:
1. File format:
    a. Entire manual in PDF format.
        1) Include text and drawing information.
        2) Provide a single PDF file even if the hard copy version is broken into separate binders due to being large.
        3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.).
            a) If material is not available in native format and only available in paper format, remove smudges, fingerprints, and other extraneous marks before scanning to PDF format.
            b) Hard copy record drawing requirements:
                (1) Provide a single multipage PDF file of each set of the scanned drawings.
                (2) Page 1 shall be the cover of the drawing set.
            c) At file opening, display the entire cover.
                (1) Scan drawings at 200 to 300 dots per inch (DPI), black and white, Group IV Compression, unless otherwise specified.
                (2) Scan drawings with photos in the background at 400 dots per inch (DPI), black and white, Group IV Compression.
        4) Pagination and appearance to match hard copy.
        5) Searchable.
        6) Scanned images are not acceptable.
        7) Bookmarks:
            a) Bookmarks shall match the table of contents.
            b) Bookmark each section (tab) and heading.
            c) Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
            d) At file opening, display all levels of bookmarks as expanded.
        8) Thumbnails optimized for fast web viewing.
    b. Drawing requirements:
        1) Provide additional copy of drawings in most current version of AutoCAD format.
        2) Drawings shall have a white background.
        3) Drawing shapes shall not degrade when closely zoomed.
        4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
        5) Delete items or options not provided in the supplied equipment or system.
2. Media:
    a. CD-ROM or DVD-ROM compatible with Microsoft Windows.
    b. Flash drive.
    c. Secure File Transfer Protocol (SFTP).
3. Label media with the following information:
    a. Operation and Maintenance Manual.

b. Equipment name.
c. Specification Section Number
d. Equipment tag number.
e. Owner's name.
f. Project number and name.
g. Date.

4. If multiple submittals are made together, each submittal must have its own subdirectory that is named and numbered based on the submittal number.

1.05 CONTENTS

A. Label the spines:
1. Equipment name.
2. Tag number.
3. Project name.
4. Owner name.

B. Cover page:
1. Operation and Maintenance Manual.
2. Equipment name.
3. Specification Section Number
4. Equipment tag number.
5. Owner's name.
6. Project number and name.
7. Date.

C. Table of Contents: General description of information provided within each tab section.

D. Equipment Summary Form: Completed form as specified in Appendix A of this Section.

E. Equipment Maintenance Summary Form: Completed form as specified in Appendix B of this Section.

F. Electric Motor Technical Data Form: Completed form as specified in Appendix C of this Section.

G. Description of equipment function, normal operating characteristics, and limiting conditions.

H. Manufacturer's product data sheets:
1. Where printed material covers more than 1 specific model, indicate the model number, calibrated range, and other special features.

I. Assembly, installation, alignment, adjustment, and checking instructions.

J. Storage instructions: Control diagrams:
1. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer-based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
2. Complete set of 11-inch by 17-inch drawings of the control system.

3. Complete set of control schematics.

K. Programming: Copies of Contractor furnished programming.

L. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

M. Operating procedures:
   1. Step-by-step instructions including but not limited to the following:
      a. Safety precautions.
      b. Guidelines.
      c. Manual keyboard entries.
      d. Entry codes.
      e. System responses.
      f. Other information as needed for safe system operation and maintenance.
   2. Modes:
      a. Startup.
      b. Routine and normal operation.
      c. Regulation and control.
      d. Shutdown under specified modes of operation.
      e. Emergency operating shutdown.

N. Preventative maintenance procedures:
   1. Recommended steps and schedules for maintaining equipment.
   2. Troubleshooting.

O. Lubrication information: Required lubricants and lubrication schedules.

P. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

Q. Parts list:
   1. Complete parts list for equipment including but not limited to the following information:
   2. Catalog data: Generic title and identification number of each component part of equipment.
   3. Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
   4. Availability.
   5. Service locations.

R. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.

S. Engineering data:
   1. Drawings: Complete set of 11-inch by 17-inch equipment drawings.
   2. Exploded view or plan and section views with detailed callouts.
   3. Outline, cross-section, and assembly drawings.
   4. System drawings: Provide interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.

5. Packaged equipment system drawings: Provide instrumentation loop drawing, control schematic diagrams, interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.
6. System drawings and data sheets: Include drawings and data furnished by the Engineer and the Supplier; provide "as installed" version.
7. Provide electrical and instrumentation schematic record drawings.

T. Test data and performance curves, when applicable.

U. Manufacturer's technical reference manuals.

V. Source (factory) Test results: Provide copies of Source Tests reports as specified in technical sections.

W. Functional Test results: After Functional Tests are completed, insert Functional Test reports as specified in technical sections.

1.06 ARCHIVAL DOCUMENTATION

A. Typically does not require updating to remain valid and should be stored in a format that preserves the document and limits one's ability to make changes.

B. Types of archival documents include the following:
1. Record drawings.
2. Reports.
3. Specifications.
4. Shop drawings.
5. Vendor Equipment O & M Manuals.
6. Photos.
7. Demonstration and training videos.
8. Other.

1.07 LIVING DOCUMENTATION

A. Requires periodic updates to remain valid and should be stored in formats that are easy to update.

B. Types of living documents include the following:
1. Facility O&M Manuals.
2. Standard Operating Procedures.
3. Other.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A
EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT IDENTIFICATION NUMBER(S) _____
(maps equipment number)

4. LOCATION OF EQUIPMENT _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

_____

_____

_____

NAMEPLATE DATA -

Horsepower _____
Amperage _____
Voltage _____
Service Factor (S.F.) _____
Speed _____
ENC Type _____
Capacity _____
Other _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

Name _____

Address _____

Telephone Number _____

8. MAINTENANCE REQUIREMENTS _____

_____

_____

9. LUBRICANT LIST _____

_____

10. SPARE PARTS (recommendations) _____

_____

11. COMMENTS _____

APPENDIX B

EQUIPMENT MAINTENANCE SUMMARY

1. Equipment Item: _____
2. Manufacturer: _____
3. Serial No. (if applicable): _____
4. Manufacturer's Order No. (if applicable): _____
5. Nameplate Data (horsepower, voltage, speed, etc.): _____

   _____
6. Manufacturer's Local Representative:

   Name: _____

   Address: _____

   Telephone: _____
7. Maintenance Requirements:

Maintenance Operation	Frequency	Lubricant (if applicable)	Comments
(List each operation required. Refer to specific information in Manufacturer's Manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

8. Lubricant List:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 7 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

9. Spare Parts: (Include recommendation on what spare parts should be kept on the job):

_____

_____

APPENDIX C

ELECTRIC MOTOR TECHNICAL DATA

Technical Data for Each Motor:

Application: _____

Manufacturer: _____

Frame No.: _____ Type: _____

Code Letter: _____ Design Letter: _____

Rating:

Horsepower: _____Voltage: _____ Phase: _____

Cycles: _____Full Load rpm: _____

(wound rotor secondary)

Volts: _____ Amperes: _____

Full Load Current: _____ amperes

Locked Rotor Current: _____ amperes

Locked Rotor or Starting Torque (percent of full load): _____ percent

Full Load Torque: _____ ft-lb

Breakdown Torque: _____ percent

Efficiency:		Power Factor:	
Full Load:	_____ percent	Full Load	_____ percent
3/4 Load:	_____ percent	3/4 Load:	_____ percent
1/2 Load:	_____ percent	1/2 Load:	_____ percent

Insulation:

Type: _____

Class: _____

Temperature Rise: _____ Above Ambient: _____

Enclosure: _____

Net Weight: _____ lbs

Wk^2: _____ lbs/sq ft

Type of Bearings: _____

Service Factor: _____

Noise Level in Decibels: _____

Heaters: _____ kW, _____ Phase, _____ volts

Altitude: _____

SECTION 01783

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Warranty and bonds requirements.

1.02 SUBMITTALS

A. For each item of material or equipment furnished under the Contract:
   1. Submit form of manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
   2. Submit form of manufacturer's special warranty when specified.

B. Provide consolidated warranties and bonds within 15 calendar days of Substantial Completion.
   1. Contents:
      a. Organize warranty and bond documents:
         1) Include Table of Contents organized by specification section number and the name of the product or work item.
      b. Include each required warranty and bond in proper form, with full information, are certified manufacturer as required, and are properly executed by Contractor, or subcontractor, supplier, or manufacturer.
      c. Provide name, address, phone number, and point of contact of manufacturer, supplier, and installer, as applicable.
   2. Hardcopy format:
      a. Submit 2 copies.
      b. Assemble in 3 D-side ring binders with durable cover.
      c. Identify each binder on the front and spine with typed or printed title "Warranties and Bonds"; Project Name or Title, and the Name Address and Telephone Number of the Contractor.
   3. Electronic copy in PDF format:
      a. Submit 1 copy.

1.03 OWNER'S RIGHTS

A. Owner reserves the right to reject warranties.

B. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

1.04 RELATIONSHIP TO GENERAL WARRANTY AND CORRECTION PERIOD

A. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both Contractor's general warranty and the correction period requirements.

B. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor's general warranty, nor does such affect or limit Contractor's performance obligations under the correction period.

1.05 MANUFACTURER'S WARRANTY MINIMUM REQUIREMENTS

A. Written warranty issued by item's manufacturer.

B. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner.

C. Covers all costs associated with the correction of the defect, including but not limited to removal of defective parts, new parts, labor, and shipping.
   1. When correcting warranted Work that has failed, remove and replace other Work that had been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

D. Provides a timely response to correct the defect.
   1. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.
   2. In the case that Owner has to provide temporary equipment to replace function of warranted item requiring repair or replacement, manufacturer shall reimburse Owner for such costs associated with the temporary equipment.

E. Warranty commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.

F. Duration of Warranty: 1 year.

1.06 MANUFACTURER'S SPECIAL WARRANTY

A. Manufacturer's special warranty is a written warranty published by the manufacturer which includes the requirements specified in the section where the item is specified.
   1. Includes Project-specific information and requirements, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner. Technical sections indicate Project-specific requirements that differ from the minimum warranty requirements for that item.
      a. Examples include extending the duration of manufacturer's warranty or to provide increased rights to Owner.

1.07 WARRANTY WORK

A. Contractor's responsibilities:
   1. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the product, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

B. Replacement cost:
   1. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of the Contract Documents.
      a. Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.

C. Related damages and losses:
   1. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

D. Owner's recourse:
   1. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.

E. Reinstatement of warranty:
   1. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
      a. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.08 IMPLIED WARRANTIES

A. Warranty of title and intellectual rights:
   1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
   2. Provisions on intellectual rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Implied warranties: Duration in accordance with Laws and Regulations.

1.09 BONDS

A. Equipment bond and other bond requirements as specified in the technical sections.

B. Bonds commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of bond period.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02050

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Material requirements for soils and aggregates.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. C535 - Standard Test Method for Resistance to Degradation of Larger-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   5. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   6. D2844 - Standard Test Method for Resistance R-Value and Expansion Pressure of Compacted Soils.
   7. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   8. D4829 - Standard Test Method for Expansion Index of Soils.
   9. D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.

B. Utah Department of Transportation (UDOT):
   1. Standard Specifications for Road and Bridge Construction (Standard Specifications).

1.03 SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: Reports for tests required by Sections of Standard Specifications.
   2. Certificates of Compliance: Certificates as required by Sections of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

B. Comply with Standard Specifications storage requirements, if applicable.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.

B. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

C. Comply with soil and aggregate material requirements in the Standard Specifications, unless specified otherwise.

2.02 NATIVE MATERIAL

A. Native soil:
   1. Sound, earthen material.
   2. Expansion index less than 35 when tested in accordance with ASTM D4829.
   3. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1-inch	100
Number 200	30 maximum

B. Native soil-select:
   1. Sound earthen material.
   2. Sum of plasticity index when tested in accordance with ASTM D4318 and the percent of material by weight passing a Number 200 sieve shall not exceed 23 when tested in accordance with ASTM C136.
   3. Organic content not be greater than 3 percent by volume.
   4. Corrosion resistance requirements:
      a. Resistivity minimum (wet aggregates): 5,000 ohm-cm.
      b. pH: 5.0 to 12.0.
      c. Chlorides maximum: 100 parts per million.
      d. Sulfates maximum: 200 parts per million.

2.03 AGGREGATE BASE COURSE

A. Material requirements:
   1. Crushed gravel as specified in the Utah Manual of Standard Specifications.
   2. Untreated base course.
   3. Consists of hard durable particles of fragments of stone or gravel; screened or crushed to required size and grading; and free from organic matter, lumps or balls or clay, alkali, or other deleterious matter.
   4. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

5. Aggregate base course for structures:
   a. Consists of crushed or fragmented particles.
6. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
   a. Percentage of wear: Not to exceed 40 percent after 500 revolutions when tested in accordance with ASTM C131.
   b. Plasticity index: Not be more than 5 when tested in accordance with ASTM D4318.
   c. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
1/2 inch	79 - 91
Number 4	49 - 61
Number 16	27 - 35
Number 200	7 - 11

2.04 GRAVEL

A. Material requirements:
   1. Consists of hard, durable particles or fragments of stone or gravel; screened or crushed to specified sizes and gradations; and free from organic matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
   2. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      a. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
      b. Plasticity index: Not greater than 5 when tested in accordance with ASTM D4318.
      c. Liquid limit: Not greater than 25 percent when tested in accordance with ASTM D4318.
   3. Conforms to sizes and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve	
	Type A	Type B
3 inch	100	--
1-1/2 inch	--	100
Number 4	30 - 75	30 - 70
Number 8	20 - 60	20 - 60
Number 30	10 - 40	10 - 40
Number 200	0 - 12	0 - 12

2.05 DRAIN ROCK

A. Material requirements:
   1.
   2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
   3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
   4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 2

2.06 STABILIZATION MATERIAL

A. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.

B. Consists of clean, hard, durable particles of crushed rock or gravel; screened or crushed to the specified sizes and gradations; and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

C. Shall be free of slaking or decomposition under the action of alternate wetting and drying.

D. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having 3 or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes the 3/8-inch sieve but is retained on the Number 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.

E. Conforms to size and grade when tested in accordance with ASTM C117 and ASTM C136.

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
3/4 inch	90 - 100
Number 4	0 - 10
Number 200	0 - 2

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02200

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Clearing and grubbing, project site.

1.02 DEFINITIONS

A. Clearing: Consists of removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which interferes with construction operations or are designated for removal.

B. Grubbing: Consists of the removal and disposal of wood or root matter below the ground surface remaining after clearing and includes stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 6 inches below the ground surface.

C. Sludge:
   1. Sludge contains both inert and organic material and is classified as a “Class B” product in accordance with 40 CFR 503.

1.03 QUALITY ASSURANCE

A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.04 PROJECT CONDITIONS

A. Environmental requirements:
   1. Sludge and sludge-entrained soils are not hazardous materials.

1.05 SEQUENCING AND SCHEDULING

A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

B. Sludge: Contractor shall excavate the sludge slurry and haul and dispose of the material at the onsite monofill. Assume two feet of sludge slurry of variable consistency to be removed from each Reclaim Pond. See Specification 01140 - Work Restrictions for more details.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. Clearing:
   1. Clear areas where construction is to be performed and other areas as indicated on the Drawings, or specified in this Section, of fences, lumber, walls, stumps, brush, roots, weeds, trees, shrubs, rubbish, and other objectionable material of any kind which, if left in place, would interfere with proper performance or completion of the work, would impair its subsequent use, or form obstructions.
   2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.

B. Grubbing:
   1. From excavated areas: Grub stumps, roots, and other obstructions 3 inches or over in diameter to depth of not less than 18 inches below finish grade.
   2. In embankment areas or other areas to be cleared outside construction area: Do not leave stumps, roots, and other obstructions higher than the following requirements:

Height of Embankment over Stump	Depth of Clearing and Grubbing
0 feet to 2 feet	Grub stumps or roots 3 inches or over in diameter to 18 inches below original grade. Cut others flush with ground.
2 feet to 3 feet	Grub stumps 1 foot and over in diameter to 18 inches below original grade. Cut others flush with ground.
Over 3 feet	Leave no stumps higher than stump top diameter, and in no case more than 18 inches.

   3. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.

END OF SECTION

SECTION 02240

DEWATERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation and maintenance of dewatering systems.
   2. Disposal of water entering excavation or other parts of the work.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4X enclosure in accordance with NEMA 250.

1.04 DESIGN CRITERIA

A. Design requirements:
   1. Keep excavations reasonably free from water. Draw down static groundwater level to minimum of 3 feet below anticipated bottom of excavations before the excavation reaches bottom elevation.
   2. Dewatering design analysis. Include the following:
      a. Evaluation of anticipated subsurface conditions.
      b. Required well spacing.
      c. Diameter of wells.
      d. Depth to screen, screen height, and mesh size.
      e. Backfill and filter pack.
      f. Pump size.
      g. Drawdown duration.
      h. Drawdown and steady state flow rates.
      i. Anticipated area influenced by dewatering system and potential impacts to adjacent structures, existing and proposed. Mitigation measures needed to prevent any expected settlements. Contingency plan for restoring nearby structures if settlement is observed as result of dewatering operations.
      j. Expected settlements.
   3. Include water drawdown curves in dewatering calculations.
   4. Coordinate dewatering design with excavation and shoring design. Excavation and shoring design shall consider changes in groundwater conditions and associated earth pressures.
   5. Do not place concrete or masonry foundations or concrete slabs in water. Do not allow water to rise over these elements until concrete or mortar has set for at least 24 hours.
   6. Maintain operation of dewatering system until complete structure -- including walls, slabs, beams, struts, and other structural elements -- has been

constructed; concrete has attained its specified compressive strength; and backfill has been completed to finished grade.

7. Provide standby power to ensure continuous dewatering in case of power failure.

B. Dewatering shored excavations:
   1. Dewater from within shoring.
   2. Use impermeable shoring system to minimize lowering of groundwater outside shoring.
   3. Extend impermeable shoring below bottom of excavation sufficient amount to:
      a. Minimize lowering of groundwater outside shoring.
      b. Prevent unstable excavation due to piping and heave.
   4. To minimize settlement outside shoring due to dewatering, do not lower groundwater outside shoring more than 1 foot. Provide groundwater recharge if required to maintain this groundwater elevation outside of shoring.
   5. Provide monitoring wells located outside shoring for monitoring groundwater elevation.

C. Obtain written permission from Engineer before locating wells, well points, or drain lines for dewatering within the limits of a structure's foundation.

D. Locate dewatering facilities where they will not interfere with utilities and construction work to be performed by others.

E. Discharge:
   1. Discharge water to existing reclaim pond or sludge lagoon in service.
   2. Discharge to manholes or storm drain inlets will not be permitted.

1.05 SUBMITTALS

A. Dewatering plan:
   1. Dewatering design analysis.
   2. Required permits.
   3. Arrangement, location, and depths of dewatering system components.
   4. Type and sizes of filters.
   5. Identify proposed alignment, support, and protection for discharge pipe. Identify location of discharge and provide details for that location. Well construction logs. Include:
   6. Descriptions of actual materials encountered, categorized in accordance with Unified Soil Classification System.
   7. Construction details.
   8. Well development procedures and results.
   9. Deviations from original design.

B. Qualifications:
   1. Dewatering contractor.
   2. Dewatering design engineer.
   3. Testing laboratory.

1.06 QUALITY ASSURANCE

A. Dewatering plan and dewatering system analysis:
   1. Prepared by a qualified Civil Engineer, licensed in Utah.

a. The dewatering design engineer shall have at least 5 years of experience in designing similar systems.

B. Dewatering Contractor shall have at least 5 years of experience in installing similar systems.

C. Testing laboratory shall meet discharge permit testing laboratory qualifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 INSTALLATION

A. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with Contractor.

B. During construction, provide and maintain ample means and devices to promptly remove and properly dispose of water entering excavation or other parts of the work, whether water is surface water or underground water.

C. Keep excavations reasonably free of water.

D. Make provisions to maintain continuous dewatering:
1. Provide standby power to maintain dewatering during power outages and interruptions.
2. Provide 24-hour monitoring by personnel skilled in operation and maintenance of the system, and capable of providing or obtaining work required to maintain system operation.

E. Intercept and divert precipitation and surface water away from excavations. Use dikes, curb walls, ditches, pipes, sumps, or other means acceptable to Engineer.

F. Disposal of water:
1. Dispose of water from the work in suitable manner without damage to adjacent property.
2. Do not drain water into work built or under construction.
3. Properly dispose of discharge water in accordance with Federal, State, and local requirements and permits and in such manner that it will not be a menace to public health or safety.
4. For discharge of water into holding tanks or infiltration ponds, include a means of overflow protection that is acceptable to Engineer.

G. Wells, well points, and drain lines for dewatering:
1. Provide after receiving Engineer's written acceptance.
2. Fill dewatering wells, pipes, and french drains to be left in place within structure foundation limits with Class “C” concrete as specified in Section 03300 - Cast-in-Place Concrete or grout as specified in Section 03600 - Grouting.

3.02 CONSTRUCTION

A. Prior to release of groundwater to its static level: Confirm that:
   1. All groundwater pressure relief devices for structure are fully operational.
   2. Construction of structure is complete and concrete has reached its specified compressive strength.
   3. Backfill of structure is complete.

B. Control release of groundwater to its static level to prevent disturbance of natural foundation soils or compacted backfills and fills and to prevent flotation or movement of structures, pipelines, or other facilities.

END OF SECTION

SECTION 02260

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for designing, providing, maintaining, and removing excavation support and protection.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.

B. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
   1. Design Manual 7.2 - Foundations and Earth Structures.
   2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.

C. United States Steel Corporation (USS):
   1. Steel Sheet Piling Design Manual.

1.03 DEFINITIONS

A. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.

B. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes cantilevered sheet piling, trench boxes, internally braced sheet piling, slurry walls, and other similar shoring systems. Sloping of the soil is not shoring.

C. Support levels: Level of tiebacks, wales, rackers, bottom of excavation, and other types of support.

1.04 SYSTEM DESCRIPTION

A. Where general engineering design practice is specified, provide drawings and calculations that are performed and signed by civil or structural engineer registered in State where Project is located:
   1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
   2. Submit list of references acceptable to Engineer that substantiating appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:
   1. General:
      a. For trench excavations 5 feet or more in depth and for trenches less than 5 feet in depth when there is potential for cave-in.

1) Perform design pursuant to general engineering design practice.

b. Dewatering:
   1) Dewater soil inside shoring as specified in Section 02240 - Dewatering.
   2) Do not lower groundwater outside of shoring more than 1 foot.
   3) Recharge groundwater outside shoring to limit groundwater draw down outside of shoring to amount specified above.
c. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code as specified in Section 01410 - Regulatory Requirements, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
d. Minimum safety factor used for design shall not be less than 1.5.
e. The calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
f. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
g. The location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
h. Generally acceptable references for design of shoring and excavations are as follows:
   1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
   2) NAVFAC Design Manual 7.2.
   3) NAVFAC Design Manual 7.3.
   4) USS Steel Sheet Piling Design Manual.
i. Maximum total deflection of shoring at any point on shoring shall not be more than 1/2 inch.

2. Soil anchors, rock anchors, and deadman anchors:
   a. Design tieback anchors for a safety factor of not less than 2 times calculated load from shoring.
   b. Proof load all production anchors to 150 percent of calculated load from shoring.
   c. Lock off production anchors at calculated load from shoring.
   d. Length of soil anchors used to calculate resistance to load from shoring shall not include any length within potential active pressure soil failure zone behind face of shoring.
   e. Design tie rods for tieback anchors for 130 percent of calculated load from shoring.
   f. Design tie rods for tieback anchors for 150 percent of the calculated load from shoring when tie rod couplers are used and for other conditions where stress concentrations can develop.
3. Set inside face of shoring back from structure not less than greater of following:
   a. 5 feet from face of wall.
   b. 2 foot 6 inches from edge of foundation.
   c. Depth of excavation below bottom of foundation.

C. Performance requirements:
   1. General:
      a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
      b. Specified provisions:
         1) Complement, but do not substitute or diminish, obligations of Contractor for furnishing of safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of Work, structures, and other improvements.
         2) Represent minimum requirement for:
            a) Number and types of means needed to maintain soil stability.
            b) Strength of such required means.
            c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
   2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
   3. Provide support for trench excavations for protection of workers from hazard of caving ground.
   4. Provide shoring:
      a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
         1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
         2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.
      b. For trenches 5 feet and deeper.
      c. For trenches less than 5 feet in depth, when there is potential for cave-in.
      d. Where indicated on the Drawings.
   5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
      a. Using stiff shoring systems.
      b. Following appropriate construction sequence.
      c. Using shoring system that is tight enough to prevent soil loss through the shoring.
      d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
      e. Design for safety factor of not less than 1.50.
      f. Providing surface runoff routing and discharge away from excavations.
      g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
      h. Where sheet piling is used, use interlocking type sheets:
         1) Sheet piles shall be continuous and driven in interlock.
         2) If bottom of the excavation is located below the water table, use “ball and socket” or "thumb and finger" type interlock.

i. Not applying shoring loads to existing structures and other improvements.
j. Not changing existing soil loading on existing structures and other improvements.
k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

1.05 SUBMITTALS

A. Shop drawings and calculations:
1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
2. Sketches showing the condition at various stages of installation and removal of shoring.
3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.
4. When utilities penetrate shoring, show location of penetrations on elevation of all sides of shoring.
5. Show details for ground support and sealing around utility penetrations.
6. Indicate method used for installing driven shoring.

B. Control points and schedule of measurements:
1. Submit location and details of control points and method and schedule of measurements.
2. Survey data.

C. Detailed sequence of installation and removal of shoring:
1. Consider effects of ground settlement in sequence of installation and removal of shoring.
2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.

D. Submit submittals for excavation support and protection as complete package and include all items required in this Section:
1. Incomplete submittals will not be reviewed and will be returned for resubmittal as complete package.

E. Submit dewatering submittals as specified in Section 02240 - Dewatering with submittals for excavation support and protection.

1.06 SEQUENCING

A. Do not begin construction of any shoring or excavation operations until:
1. Submittals for shoring and dewatering have been accepted.
2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
3. Materials necessary for installation are on site.

B. Submit submittals minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Installation of shoring:
   1. Install means for providing safe and stable excavations as indicated in submittals.

B. Removal of shoring:
   1. Except for slurry walls and similar shoring systems, remove shoring by completion of Work.
   2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
   3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
      a. Inject grout starting at bottom of void and progressively fill void to grade.
      b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
   4. Pressure preservative treated wood lagging may be left in place if acceptable to Engineer.

C. Control points:
   1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
      a. Set control points on shoring support system:
         1) Set points at distances not exceeding 25 feet at each support level.
   2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
   3. Perform horizontal and vertical survey and measurement of control points at least once every week.
      a. Field notes shall show current measurement and change in measurement from first measurement taken.
   4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
   5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.

D. Maintenance:
   1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to Engineer.
   2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to site grading for buildings, basins, reservoirs, boxes, roads, and other facilities.
   2. Backfilling and compacting under and around structures.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. D698-Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
   2. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

A. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.

B. Embankments: Dikes, levees, berms, and similar facilities.

C. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
   2. Obtain acceptable import material from other sources if surplus obtained within Project site does not conform to specified requirements or are not sufficient in quantity.
   3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

1.05 SUBMITTALS

A. Copy of Property Owner's Agreement allowing placement of surplus soil material on their property.

B. Excavation plan.

C. Testing lab: Submit Contractor's proposed testing laboratory capabilities and equipment.

D. Test reports:
   1. Submit certified test reports of all tests specified to be performed by the Contractor.
   2. Sign and seal test reports by a registered Civil Engineer who practices geotechnical engineering registered in Utah.

1.06 QUALITY ASSURANCE

A. Initial compaction demonstration:
   1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. 50 cubic yards of backfill adjacent to structures.
      b. 100 cubic yards of embankment work.
      c. 100 cubic yards of fill.
      d. 50 cubic yards of roadway base material.
      e. 100 cubic yards of road fill.
   2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
   3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

B. Contractor shall perform all work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP).

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water for compacting: Use water from source acceptable to Engineer.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course, Class 2 permeable, controlled low-strength material, drain rock, gravel, native material, sand, select material, and stabilization material where specified or indicated on the Drawings.
      b. If suitable surplus materials are available, obtain native material and select material from cut sections or excavations or imported materials.
   2. Aggregate base course materials: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   3. Drain rock: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   4. Gravel: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   5. Native material: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   6.
   7. Stabilization material: As specified in Section 02050 - Soils and Aggregates for Earthwork.

C. Controlled low-strength material: As specified in Section 02312 - Controlled Low Strength Materials (CLSM).

D. Geotextile fabrics:
   1. Filter fabric: As specified in Section 02620 - Filter Fabric.
   2. Stabilization fabric: As specified in Section 02621 - Stabilization Fabric.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Character and quantity of material:
      a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
      b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in work to be performed.
      c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from onsite excavations or imported materials. Include in cost of work to be performed.
      d. Include wasting of excess material, if required, in cost of work to be performed.

3.02 PREPARATION

A. Backfills:
   1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified before placing backfill material or concrete.

3. Do not place backfill against walls until:
    a. Walls have been cast full height of structure and concrete has reached the specified strength.
    b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
4. Prior to backfilling:
    a. Remove all forms.
    b. Clean all trash and debris from the excavation site.
5. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.

B. Embankments:
1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for embankments before placing of embankment material.

C. Fills:
1. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for compacted fills before placing of fill material or concrete.

D. Roadway fills:
1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.

E. Sloped surfaces for fill or foundations:
1. Foundations for fill having slopes in excess of 1 vertical to 4 horizontal:
    a. Bench or terrace to adequately key existing ground and fill built thereon.
2. Slopes of original hillsides and old fills: Bench minimum of 5 feet horizontally as fill is placed.
3. Provision of new benches:
    a. Start new bench wherever vertical cut of next lower bench intersects existing grade.
    b. Recompact material thus cut out along with new embankment material at no additional cost to the Owner.

3.03 INSTALLATION

A. General:
1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.

2. Dispose of surplus material on private property only when written permission agreement is furnished by owner of property. Submit copies of such agreements.
3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from project site at no additional cost to the Owner.
4. Stabilization of subgrade: Provide materials used, or perform work required, to stabilize subgrade so it can withstand loads that may be placed upon it by Contractor's equipment.

B. Borrow area: There is no borrow area on Project site.
1. Where material is required, import material from source located off Project site selected by the Contractor and subject to acceptance by the Engineer.
2. There will be no additional cost to the Owner for use of imported material.

C. Compaction:
1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
2. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D1556, or with ASTM D6938.
4. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D698.
5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill. The depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
6. Compact to percentage of maximum density as follows:
    a. Backfill adjacent to structures: 95 percent.
    b. Backfilling voids: 95 percent.
    c. Embankments: 95 percent.
    d. Other areas: 85 percent.
    e. Spoil areas indicated on the Drawings: No minimum required.
    f. Under present and future structures: 95 percent.
    g. Under roadways, parking and storage areas, curbs, and sidewalks: 95 percent.
    h. Upper 6 inches of cuts: 95 percent.
    i. Fills: 95 percent.

D. Dewatering: As specified in Section 02240 - Dewatering.

E. Excavation:
1. Blasting: Not permitted.
2. Excavations for trenching: As specified in Section 02318 - Trenching.
3. Excavations for structures:
    a. Provide excavations conforming to dimensions and elevations indicated on the Drawings for each structure.

b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by Engineer, do not carry excavations below elevation indicated on the Drawings.
c. Where soil is encountered having unsuitable bearing value, Engineer may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:
1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
2) Under footings: Restore to the proper elevation using one of the following:
a) Aggregate base course.
b) Controlled low-strength material.
e. Excavation width:
1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
2) Do not undercut slopes.
f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.

4. Necessary over excavation:
a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
b. Backfill voids with material acceptable to the Engineer:
1) With acceptance of the Engineer, backfill with one of the following:
a) Aggregate base course.
b) Controlled low-strength material.

F. Materials for backfills, embankments, fills, and roadway fills:
1. General:
a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within Project site do not conform to specified requirements or are not sufficient in quantity for construction of Project.
2. Backfills:
a. Backfill adjacent to structures, slabs, or walls: Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
b. Backfill material under concrete structures: Aggregate base course material, except in areas where controlled low-strength material or concrete encasement are indicated on the Drawings.
c. Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
3. Embankments:
a. Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.

4. Fills:
    a. Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
    b. Extend fill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
5. Roadway fills: One of the following, unless otherwise specified or indicated on the Drawings:
    a. Aggregate base course material.

G. Placement:
1. General:
    a. Lines and grades:
        1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
        2) Overbuild all permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
2. Backfills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted backfills: Remove and recompact.
3. Fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted fills: Remove and recompact.

4. Embankments:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted embankments: Remove and recompact.
5. Roadway fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted roadway fills: Remove and recompact.

3.04 FIELD QUALITY CONTROL

A. Confirmation tests:
1. Contractor's responsibilities:
    a. Adequacy of compaction equipment and procedures:
        1) Demonstrate adequacy of compaction equipment and procedures.
        2) At each test location include tests for each type or class of backfill from bedding to finish grade.
    b. Compaction sequence requirements:
        1) Do not perform additional earthwork of the same kind until specified degree of compaction has been demonstrated.

c. Cost of confirmation tests: Paid for by the Contractor.
d. Qualifications of Contractor's testing laboratory: Acceptable to Engineer.
e. Copies of confirmation test reports: Submit promptly to the Engineer.

B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
2. Unlined channels and basins:
a. In both cut and fill, and levee and access roadside slopes in cut: Vertical tolerance of none above and 3 inches below grade indicated on the Drawings on bottom and side slopes.
b. On top surface of levee and access road in both cut and fill, and levee and access roadside slopes in fill: Vertical tolerance of none below and 3 inches above grade indicated on the Drawings.
3. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6 inches deep.
b. Intent of proceeding is to avoid sandy or gravelly areas.
4. Finish grading of surfaces:
a. Reasonably smooth, compacted, and free from irregular surface changes.
b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
c. Uniformly grade areas that are not under concrete.
d. Finish ditches and gutters so that they drain readily.

C. Compliance tests:
1. Frequency of testing: Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 02312

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controlled low strength material (CLSM), also known as "flowable fill."

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 229R - Report on Controlled Low-Strength Materials.
   2. 301 - Specifications for Structural Concrete.

B. ASTM International (ASTM):
   1. C33 - Standard Specification for Concrete Aggregates.
   2. C94 - Standard Specification for Ready Mix Concrete.
   3. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
   4. C150 - Standard Specification for Portland Cement.
   5. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   6. C494 - Standard Specification for Chemical Admixtures for Concrete.
   7. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   8. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3).
   9. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).
   10. D4832 - Standard Test Method of Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   11. D5971 - Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material.
   12. D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material.

1.03 SYSTEM DESCRIPTION

A. Mixture of portland cement, water, pozzolan, fine aggregate and admixtures, proportioned in accordance with the recommendations of ACI 229 to produce a homogeneous mixture that is flowable, that will readily work into corners and angles; that will not segregate in the plastic state; and that is self-compacting at the time of placement without the use of mechanical vibration.

B. Performance requirements:
   1. Air content, total calculated in accordance with ASTM D6023: Not less than 8.0 percent, nor greater than 12.0 percent.
   2. Compressive strength, measured in accordance with ASTM D4832 at 28 days: Not less than 50 pounds per square inch, nor greater than 150 pounds per square inch.

3. Wet density: Not greater than 132 pounds per cubic foot.
4. Slump, measured in accordance with ASTM C143 at the point of placement: Greater than 9 inches and that allows CLSM to flow freely and to be self-compacting during placement.

1.04 SUBMITTALS

A. Product data: Submit data completely describing materials in the mix and demonstrating compliance with the requirements of this Section.
   1. Cement: Mill tests. Indicate alkali content representative of each shipment.
   2. Fly ash: Identify source and type of fly ash.
   3. Water: Identify source and quality if not from a municipal treatment source.
   4. Admixtures: Manufacturer's product data indicating suitability for use in CLSM mixes and recommended dosage rates.
   5. Aggregate:
      a. Submit source, type, and sieve analyses. Include testing to demonstrate that materials in accordance with ASTM C33 requirements.
      b. Resubmit at any time there is a significant change in grading of materials.

B. Mix design:
   1. Submit full details, including mix design calculations for mix proposed for use.
   2. Trial batch test data:
      a. Submit data for each test cylinder.
      b. Submit data that identifies mix and slump for each test cylinder.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store or stockpile cement, fly ash, and aggregate in accordance with ACI 301.

B. Store admixtures in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland cement in accordance with ASTM C150, Type I or Type II.
   2. Having total alkali content not more than 0.60 percent.

B. Fly ash: Class C or Class F fly ash in accordance with ASTM C618.

C. Water:
   1. Potable water: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.

D. Admixtures: Products of a single manufacturer, specifically manufactured or recommended by that manufacturer for use in CLSM.
   1. Air entraining admixture: In accordance with ASTM C260.

E. Aggregate:
   1. Non-expansive, non-reactive, inert natural sand conforming to the following requirements:
      a. Not more than 12 percent passing a No. 200 sieve.
      b. No plastic fines present.
      c. Including pea gravel no larger than 3/8 inch.
   2. Non-expansive, non-reactive, inert natural sand in accordance with ASTM C33 for fine aggregate.

2.02 MIXES

A. See System Description for performance requirements of the plastic and hardened mix.

2.03 SOURCE QUALITY CONTROL

A. Trial batch:
   1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.
   2. Prepare trial batches using the specific cement, fly ash, admixtures, aggregates, and water proposed for the Work.
   3. Prepare trial batch with quantity sufficient to determine slump, workability, and consistency; and to provide test cylinders as indicated in this Section.

B. Trial batch testing:
   1. Determine slump in accordance with ASTM C143, with the following modifications:
      a. Do not rod the concrete material.
      b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.
   2. Prepare and test trial batch specimens in accordance with ASTM D4832, with the following modifications:
      a. Provide cylindrical test specimens, each 6-inches in diameter by 12-inch high.
      b. Provide a minimum of 8 cylinders for testing of each trial batch.
      c. Fill the molds to overflowing and tap sides lightly to settle the mix.
      d. Do not rod the mix for consolidation in the cylinder.
      e. Strike off the excess material.
   3. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   4. Do not remove the test cylinder from mold until that cylinder is to be capped and tested.
      a. Perform the capping carefully to prevent premature fractures.
      b. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.
   5. Provide compressive strength tests:
      a. Test 4 test cylinders at 7 days after casting, and another 4 cylinders at 28 days after casting.
      b. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

C. If the trial batch tests do not meet the Specifications for strength or density, revise and re-submit the mix design, prepare additional trial batch(es), and complete additional trial batch tests. Repeat until an acceptable trial batch is that conforms to the Specifications is produced.
   1. All the trial batches and acceptability of materials shall be paid by the Contractor.
   2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not place CLSM until preparation and condition of surfaces receiving the fill have been observed and accepted by the Engineer.

B. Remove debris foreign matter, and standing or running water from excavations and areas receiving CLSM before placement.

3.02 INSTALLATION

A. Pipes and trenches.
   1. Install cellular concrete as indicated on the Drawings and specified.
   2. Where CLSM is placed around and over pipes, secure pipes in place, or place CLSM in lifts to prevent pipe flotation.
   3. Where CLSM is placed in long, open trenches, confine material using bulkheads of sandbags, earth dams, or stiffer concrete at open ends of placement.

B. Soil preparation:
   1. Prior to placement of CLSM, prepare underlying soils as follows:
      a. Scarify surface to a depth of 8 inches.
      b. Adjust moisture content to or slightly above the optimum in accordance with ASTM D698.
      c. Re-compact scarified surface to a minimum of 95 percent relative density in accordance with ASTM D698.

3.03 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measure, batch, mix and transport CLSM in accordance with the requirements of ASTM C94 and this Section.

B. Mix until there is uniform distribution of materials.

C. Discharge mixer completely prior to recharging.

D. After trial batch testing and mix acceptance, maintain slump during construction within plus or minus 1 inch of the design slump.

3.04 PLACING

A. Place controlled low strength material by method that preserves the quality of the material in terms of compressive strength and density.

B. Maintain fluid properties of the mix during placement.
   1. At point of placement, provide material that flows easily around, beneath, or through walls, pipes, conduits, or other structures.
   2. Do not place CLSM that has partially hardened or that has been contaminated by foreign materials.
   3. Handle and place CLSM using methods that minimize segregation of the mix.
   4. Deposit mix as near its final position as possible to avoid segregation due to rehandling or flowing.
   5. Contain and confine mix while it is fluid. Design containment structures and bracing at walls and forms to withstand lateral pressures of wet mix.

C. Lifts:
   1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings.
   2. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent additional lateral load against the forms or structure due to the weight of the next lift of CLSM.

D. Water conditions:
   1. Do not place CLSM in standing or flowing water.
   2. Do not permit water to flow over the surface of freshly placed or un-hardened CLSM.
   3. Do not submerge CLSM in water within 24 hours after placement.

E. Manage CLSM bleed water.
   1. Grade top surface of CLSM to drain away from the fill.
   2. Provide side containment that permits bleed water to drain to a contained management area away from the fill.

3.05 CURING AND PROTECTION

A. Curing:
   1. Prior to and during curing, install barriers to prevent equipment or personnel from falling into or becoming entrapped in CLSM.

B. Protect CLSM from:
   1. Damage from the elements.
   2. Damage of any nature during surrounding construction operations.
   3. Freezing: Do not use salt, manure, or other chemicals to provide cold.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01450 - Quality Control and Section 01460 - Contractor Quality Control Plan and as specified in this Section.

B. General:
   1. Engineer inspection and acceptance required prior to placement.
   2. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Owner's Testing Laboratory in preparing said specimens.

3.07 FIELD QUALITY ASSURANCE

A. Provide quality control over the work of this Section as specified in Section 01450 - Quality Control and Section 01460 - Contractor Quality Control Plan.

B. Field inspections:
   1. Engineer shall provide on-site inspection for the Work of this Section.
   2. Advise Engineer of readiness to proceed at least 24 hours prior to each placement of CLSM.
   3. Required inspections:
      a. Engineer will observe the prepared areas. Do not place CLSM until Engineer has observed and accepted preparations.
   4. Record of inspections.

C. Special tests and inspections:
   1. As specified in Section 01455 - Special Tests and Inspections.

D. Field sampling and testing:
   1. During construction, Owner shall provide sampling and testing to determine whether the CLSM, as produced and placed, complies with the requirements specified.
      a. Make provisions for and furnish material for test specimens. Cooperate by allowing free access for Owner's independent testing firm to sample and test materials. Provide assistance in obtaining and preparing said specimens.
   2. Sample CLSM for testing in accordance with ASTM D5971.
   3. Required tests:
      a. Air content: Prepare sample and test in accordance with ASTM D6023.
      b. Compressive strength: Prepare and test cylinder specimens in accordance with ASTM D4832.
         1) Prepare 6-inch diameter by 12-inch high specimens for testing.
            a) Provide one set of specimens for each 150 cubic yards of CLSM placed, but not less than 1 set for each half day's placement.
            b) Prepare and test not less than 3 cylinders for each set.
            c) Place CLSM in the molds in accordance with ASTM D4832. Do not rod or otherwise consolidate the material in the mold.
            d) In accordance with ASTM D4832 recommendations for displacing bleed water at the top of the molds and refilling the molds before covering with a lid. Do not use air-tight lids.
         2) Place the cylinders in a safe location away from construction activities.
            a) Protect cylinders from bumping and impact.
            b) Maintain temperature surrounding cylinders between 60 and 80 degrees Fahrenheit until delivery to the laboratory for testing.
            c) After the first day, surround molds with a high humidity environment by covering with wet burlap, or equivalent highly

absorptive material. Maintain saturation of the cover. Do not sprinkle water directly on the cylinders.

3) After 4 days, place the cylinders in a protective container for transport to the laboratory for testing.
   a) Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   b) Transport container may be a box with a Styrofoam or similar lining that will limit jarring and bumping of the cylinders.
4) Upon receipt at the testing laboratory, place test cylinders in a moist curing room until dates for testing.
5) Do not remove test cylinders from molds until the day that cylinders is to be capped and tested.
6) Cap and test for compressive strength in accordance with ASTM D4832.
   a) Do not perform initial compression test until the cylinders reach an age of at least 4 days.
   b) Test 1 cylinder at 7 days and 2 at 28 days.
7) Compressive strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength specified.

3.08 NON-CONFORMING WORK

A. When testing or observation indicates CLSM with properties outside the specified and accepted range, Engineer will issue instructions regarding disposition of nonconforming materials.

B. Engineer may:
   1. Reject CLSM represented by those test specimens and require its removal and replacement.
   2. Require modification of the mix design to provide CLSM with the properties specified.

C. Make such modifications at no additional expense to the Owner and with no adjustment to the schedule.

END OF SECTION

SECTION 02318

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Trench excavation and trench backfill.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D698-Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
   2. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures.

B. Product data on soils and aggregates.
   1. Material source.
   2. Gradation.
   3. Test data to demonstrate compliance with this Section.

C. Samples:
   1. Provide 50-pound sample of materials when requested by the Engineer.

D. Confirmation testing:
   1. Certification of Contractor's testing laboratory.
   2. Record copy report for tests performed by Contractor's testing laboratory.

1.04 DEFINITIONS

A. Backfill: Material placed in trench above the pipe embedment zone.

B. Bedding: Material placed under, around, and over pipes or ducts in trenches.

C. Center bedding: Material placed at the bottom of the trench directly under the center of the pipe to provide a malleable resting surface.

D. Fine grading: Material placed directly below pipes or ducts to provide support at the bottom of the trench and to bring those elements to required grades and elevations.

E. Flexible pipe: Includes steel, ductile iron, thermoplastics such as polyvinyl chloride (PVC) and high-density polyethylene (HDPE), thermosetting plastics such as fiberglass-reinforced polymer (FRP), bar-wrapped concrete cylinder pipe, and corrugated steel pipes.

F. Haunch zone: Material placed below and beside the pipe up to the pipe springline.

G. Lift: A layer of soil or aggregate material, measured before compaction.

H. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D698.

I. Maximum density, field compaction: Soil density and water content when tested in accordance with ASTM D6938.

J. Pavement section: Includes pavement plus underlying courses such as base course and subgrade.

K. Pipe embedment zone: Includes bedding, fine grading, center bedding, and haunch zone.

L. Pipe foundation: Material placed at the bottom of trench to provide support.

M. Pipe springline: A horizontal reference line located at mid-height, or halfway point, of a circular conduit, pipe, or tunnel. It is the maximum horizontal dimension or diameter of a circular conduit, pipe, or tunnel.

N. Rigid pipe: Includes reinforced non-cylinder concrete, reinforced concrete cylinder, prestressed concrete cylinder, vitrified clay, polymer concrete, cast iron, asbestos cement and cast-in-place pipes.

PART 2 PRODUCTS

2.01 MATERIALS

A. As specified in Section 02050 - Soils and Aggregates for Earthwork.

B. Class C concrete: As specified in Section 03300 - Cast-in-Place Concrete.

C. Controlled low-strength material: As specified in Section 02312 - Controlled Low Strength Material (CLSM)

PART 3 EXECUTION

3.01 PREPARATION

A. Stabilize excavations as specified in Section 02260 - Excavation Support and Protection.

3.02 DEWATERING

A. As specified in Section 02240 - Dewatering.

3.03 TRENCH EXCAVATION

A. Excavate bottom of trench to depth indicated on the Drawings.

B. Areas of new fill or embankment:
   1. Prior to laying pipes or electrical service, place fill and compact as specified to not less than 2 feet above top of pipe, conduit, or duct bank.
   2. Excavate through fill for pipe trench.

C. Trench widths as specified in the following table:

Buried Pipe Or Accessory	Minimum Trench Width	Maximum Trench Width
Nominal Pipe Diameter: 4 inch to 24 inch	OD + 18 inches	OD + 24 inches
Nominal Pipe Diameter: Greater than 24 inch	OD + 24 inches	OD + 36 inches
Manholes, valves, or other accessories	12 inches between outer surface and trench side or shoring	Not applicable

D. Potable water pipe and appurtenances:
   1. Lay in trenches separate from those used for sewers.
   2. Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground and located at distance of not less than 10 feet from any parallel sewer trench.

E. At road crossings or existing driveways:
   1. Make provision for channel or trench crossings at these points, either by means of trenchless technologies or temporary bridges.
   2. Engineer approval for remedy, without additional cost to Owner, when trench width at top of pipe is increased beyond width specified in this Section because of soil conditions, safety requirements, or other reasons.
      a. Remedy may include upgrade laying conditions or install stronger pipe designed in accordance with Specifications.

3.04 TRENCH BACKFILL - GENERAL

A. Trench area terminology and locations as indicated on the Drawings.

B. Place material, except CLSM and concrete, in maximum 6-inch lifts, measured before compaction.

C. Backfilling of manhole excavation: Conform to backfilling requirements as specified for trenches in this Section.

3.05 PIPE FOUNDATION

A. Provide trench bottom with firm, dry, uniform bearing surface at the grade indicated on the Drawings.
   1. Prepare pipe foundation, with any unauthorized excess excavation below elevation indicated on the Drawings, at no additional cost to Owner.

B. If bottom of trench excavation consists of soil:
   1. Scarify bottom of trench to a depth of 6 inches below the grade indicated on the Drawings.

2. Materials and placement:
    a. Recompact scarified material to 95 percent of maximum density.

C. If bottom of trench excavation consists of rock or any material that, by reason of its hardness, cannot be excavated to provide uniform bearing surface:
    1. Remove such rock or other material to a depth of not less than 4 inches below pipe embedment zone.
    2. Materials:
        a. CLSM.
        b. Class C concrete.

D. If bottom of trench excavation consists of unacceptable material:
    1. Remove such unacceptable material to a depth of not less than 18 inches below pipe embedment zone.
    2. Material and placement:
        a. Aggregate base course material compacted to 95 percent of maximum density.
            1) Maximum particle size for backfill material limited as specified in the following table:

Buried Pipe	Maximum Particle Size
Nominal Pipe Diameter: 6 inch to 8 inch	3/4 inch
Nominal Pipe Diameter: 10 inch to 16 inch	1 inch
Nominal Pipe Diameter: Greater than 18 inch	1 1/2 inches

3.06 PIPE EMBEDMENT ZONE

A. General:
    1. Pipe displacement:
        a. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
        b. In event there is movement or floating of the piping, re-excavate, re-lay, and backfill the pipe.
    2. Depressions for joints or couplings:
        a. Excavate holes in graded trench bottom.
        b. Provide holes of sufficient width to provide ample room for grouting, banding, or welding as necessary for making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.

B. Rigid pipe:
    1. Fine grading:
        a. Compacted depth below bottom of pipe: 6 inch minimum.
        b. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.
    2. Bedding:
        a. Compacted depth above top of pipe: 12 inch minimum.
        b. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.

C. Flexible pipe:
   1. Center bedding:
      a. Compacted depth below bottom of pipe: 12 inch minimum.
      b. Compacted width below bottom of pipe: 1/3 of pipe outer diameter.
      c. Materials and placement:
         1) Sandbags.
         2) Uncompacted sand at uniform density, minimize compaction.
   2. Haunch zone:
      a. Materials and placement:
         1) Aggregate base course compacted to 95 percent maximum dry density.
         2) CLSM.
   3. Bedding:
      a. Compacted depth above top of pipe: 12 inch minimum.
      b. Materials and placement:
         1) Aggregate base course compacted to 95 percent maximum dry density.
         2) CLSM.

3.07 BACKFILL

A. Trenches:
   1. Materials and placement:
      a. Native soil compacted to 95 percent maximum dry density.
      b. Imported fill compacted to 95 percent maximum dry density.
      c. Aggregate base course compacted to 95 percent maximum dry density.
      d. CLSM.

B. Trenches in rock:
   1. Backfill to top of rock.
      a. Materials and placement:
         1) CLSM.
         2) Class C concrete.
   2. Backfill from top of rock to grade, if applicable:
      a. Materials and placement:
         1) Aggregate base course compacted to 95 percent of maximum density.

C. Trenches below or within 10 feet of the outside perimeter of structures:
   1. Backfill to underside of structure.
   2. Materials and placement:
      a. Aggregate base course compacted to 95 percent of maximum density.
      b. CLSM.

D. Trenches in roadways and paved areas:
   1. Backfill trench to underside of pavement.
   2. Materials and placement:
      a. Aggregate base course compacted to 95 percent of maximum density.
      b. CLSM.

E. Trenches in areas outside the improved section of roadways or in open country:
   1. Backfill to underside of topsoil layer.

2. Materials and placement:
    a. Native soil, native soil - select, imported material, or aggregate base course compacted to 95 percent of maximum density.

F. Trenches under existing intersecting pipes, duct banks, or conduits larger than 3 inches in diameter:
    1. Backfill from above top of new pipe embedment zone to springline of intersecting pipe or conduit.
        a. Extend backfill at least 2 feet on either side of intersecting pipe or conduit to ensure backfill material remains in place while other backfill is being placed.
        b. Materials and placement:
            1) CLSM, unless otherwise indicated on the Drawings.
    2. Backfill remainder of trench:
        a. Materials and placement:
            1) CLSM.
            2) Class C concrete.

3.08 EXCESS MATERIAL

A. Remove excess excavated material from the Project site as specified in Section 02300 - Earthwork.

3.09 FIELD QUALITY CONTROL

A. Provide field quality control for the Work as specified in Section 01450 - Quality Control.

B. Confirmation tests: As specified in Section 02300 - Earthwork.
    1. Minimum frequency of confirmation testing:
        a. At each test location include tests for each type or class of backfill from bedding to finished grade.
        b. For trenches in embankment: 1 location every 100 linear feet.
        c. For trenches outside embankment: 1 location every 200 linear feet.
        d. In open fields: 2 locations every 1,000 linear feet or 1 location every 200 cubic yards.
        e. Along dirt or gravel road or off traveled right-of-way: 1 location at every 500 linear feet.
        f. Crossing paved roads: 1 location at each crossing.
        g. Under pavement cuts or within 2 feet of pavement edges: 1 location every 400 linear feet.

C. Compliance tests:
    1. Make periodic compliance tests to verify that compaction is meeting requirements as specified in this Section.
    2. Perform remedial work if compaction test fails to meet specified requirements using one of the following methods:
        a. Remove and replace backfill at the proper density.
        b. Other means acceptable to the Engineer.
    3. Retesting:
        a. Costs of retesting: Contractor is responsible for the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.

b. Contractor's confirmation tests during performance of remedial work:
    1) Performance: Perform tests in manner acceptable to the Engineer.
    2) Frequency: Double amount specified for initial confirmation tests.

D. Piping system testing:
    1. As specified in Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 02553

TEMPORARY BYPASS PUMPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for temporary bypass pumping of waste washwater flows on plant sites as needed to complete the Work.

1.02 GENERAL REQUIREMENTS

A. Shutdowns over 72 hours are not permitted throughout the duration of the project. Stage construction between manholes on the 14” SL pipeline to limit shutdowns and bypass pumping.

B. Provide all necessary labor, tools, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

C. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Engineer.

D. Bypassing waste washwater in a way that ensures that no waste washwater is allowed to leak outside of the bypass system or plant facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

E. Accept responsibility for any release of waste washwater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

F. Coordinate the placement of the bypass piping and pumping equipment with the Owner.

G. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

H. Except as otherwise specified or authorized in writing, no interruption of waste washwater flow shall be permitted throughout the duration of the project. Contractor is responsible for all waste washwater overflows during construction of this work and bypass operations.

I. Take precautions to prevent any potential spillage of waste washwater from entering the stormwater system.

J. Temporary bypass pumping operation:
   1. Limited to the months, times, or seasons indicated, unless approved in writing by the Engineer.

K. Continuously monitor temporary bypass pumping while in operation.

L. Provide qualified operators continuously during operation of the bypass systems.

1.03 SUBMITTALS

A. Prepare and submit a project-specific waste washwater bypass pumping plan with completed waste washwater bypass pumping checklist.

B. Waste washwater bypass pumping plan: Include the following at a minimum:
   1. Capacities and sizes of pumps, standby equipment, and power requirements, if applicable.
   2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.
   3. Standby power generator size and location for electrically driven bypass pumps.
   4. Downstream discharge plan.
   5. Pipe thrust and restraint types, sizes, and locations.
   6. Temporary pipe supports and anchoring required.
   7. Plans for access to bypass pumping locations.
   8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.
   9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.
   10. Plan indicating bypass pumping line locations.
       a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.
   11. Detailed plans of a backup system.
   12. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions.
   13. Schematic drawings and written description of the control system and its' operating sequence.
   14. Proposed type and location of collection system plugs.
   15. Catalog cut sheets for pumping equipment, pipe and fittings, valves.
   16. Emergency response plan.
   17. Spill prevention and cleanup plan.
   18. Noise control system.
   19. Health and safety plan.

1.04 QUALITY ASSURANCE

A. Contractor's qualifications:
   1. Minimum 5 years' experience in performing substantially similar temporary bypass operations.
   2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 3 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

2.01 CAPACITY

A. Pumps, piping and accessories: Of adequate capacity and size to handle the range of waste washwater flows from minimum flow to peak flow.

B. Piping, fittings, and all accessories shall withstand 1.5 times the maximum pressure.

C. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.
   1. Provide sufficient bypass lines to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The bypass lines and separate redundant lines shall be connected via a combined header that enables the shutdown and isolation of each individual line should a leak or rupture occurs.
   2. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

2.02 BYPASS PUMPS

A. Provide a minimum of 2 pumps: 1 duty and 1 standby.

B. Pump capacity: Sufficient to pump the anticipated peak hour flow with the largest pump out of service.

C. Pumps: Packaged units with a skid base or trailer.

D. Pumps: Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

E. Pumps shall use oil-lubricated mechanical seal.

F. Pumps shall be capable of passing 3-inch diameter solids.

G. Pump driver: Diesel engine and include the following:
   1. Minimum 12-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
   2. Fuel gauge with red warning light when tank approaches empty.

H. The system shall include the following features:
   1. START/STOP operation.
   2. Variable flow based on water level in suction structure.
   3. Instrumentation and controls for operation and monitoring for each pump.

I. Comply with applicable air quality regulations.

2.03 BYPASS PIPING

A. Use HDPE piping for the temporary bypass pumping system.

B. Piping integrity: 0 leakage.

C. Provide air release valve at high point in piping and containment spills from valves.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways.
   1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with temporary asphalt concrete.
   2. No driveway access shall be blocked without the written authorization of the Owner.

2.04 PIPE PLUGS IN EXISTING PIPE

A. Pipe diameters 24 inches and smaller: Mechanical plugs with rubber gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces.

2.05 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or enclosures.

B. The noise level: At or below 75 decibels on the A-scale at 50 feet from the pumping equipment.

PART 3 EXECUTION

3.01 GENERAL

A. Notify the Owner a minimum of 14 days prior to the Work and then notify the Engineer at least 48 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking pipeline out of service, verify that bypass system is fully operational and acceptable to Engineer.

3.02 PROTECTION

A. Be responsible for all bypass flows:
   1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 2 times per shift.
   2. Do not shutdown the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

B. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.

1. In the event of any spill, be responsible for the prompt cleanup and disinfecting of the spill.
2. Compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

C. Implement measures to prevent interference between plant staff and the bypass pumping equipment, pipelines and waste washwater.

D. Take precautions to protect all bypass lines from damage.
1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

3.03 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:
1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times the maximum operating pressure.
2. Conduct test for a duration of 2 hours.
3. Test using return water.
4. The line in service after test if the pressure has been maintained and there are no observable leaks.
5. Notify Engineer at least 24 hours prior to testing.

B. Inspection:
1. Inspect temporary bypass piping system at a minimum of every hour while in operation.
2. Inspection log: Keep at each pumping location.

3.04 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling.

B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement restoration, at least equal to that which existed prior to start of Work.

3.05 SYSTEM CONDITIONS

A. Refer to Table below.

Bypass		Route		Flows (gpm)				
No.	**Description**	**From**	**To**	**Max**	**Avg**	**Min**	**Time**	**Conditions**
14” Sludge Line	Pump decant water between manholes during replacement of the 14” SL pipeline that runs from the sludge lagoons to 36” WW connection.	Sludge Lagoons	36” WW	2,500	1,000	500	8 hr/d	Shutdown more than 72 hours are not permitted.

END OF SECTION

SECTION 02600

CONCRETE MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Manhole frames and covers.
   2. Manhole grade rings.
   3. Manholes cones and risers.
   4. Manhole bases.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C150 - Standard Specification for Portland Cement.
   4. C443 - Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   5. C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
   6. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint.
   7. C923 - Standard Gide for In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors.
   8. C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

C. International Organization of Standardization (ISO):
   1. 9001 - Quality Management Standard.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Shop drawings:
   1. Manufacturer’s catalog data and details of following items for approval:
      a. Frame and covers.
      b. Grade rings.
      c. Manhole cones and risers.
      d. Manhole bases, if precast.
   2. Manhole construction details, jointing methods, connection details, materials, and dimensions.
   3. Repair procedures and details.

C. Calculations and criteria used in manhole design including material properties, loadings, load combinations, and dimensions assumed.

D. Test methods and results including certification that the manhole riser exceeds the minimum requirements in accordance with ASTM C478.

E. Sealed drawings and design calculations by a registered Professional Engineer licensed in the State where the project is located.

F. Certificates
   1. ISO 9001 certificate by a third party confirming that ASTM test reports are valid and up to date at the time of the bid and during construction period.
   2. Manufacturer's Certificate of Source Testing.

1.04 PRODUCT REQUIREMENTS

A. As specified in Section 01600 - Product Requirements.

B. Provide suitable quantities of lifting equipment to handle the manholes/risers and castings.
   1. In no case shall any equipment be used that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the manhole components.
   2. Dragging or dropping the manhole components shall not be allowed.

C. Source testing.
   1. Perform pre-production and post-production tests by manufacturer staff with a minimum of 5 years of experience in quality control, inspection, and testing of manholes.
      a. In lieu of this experience, witness of tests by up to 3 full-time Owner representatives.
   2. Examine each completed manhole section for dimensional requirements, strength, and workmanship.
   3. Complete required testing in accordance with ASTM C478.
   4. Provide the Manufacturer's Certificate of Source Testing.

1.05 DESIGN CRITERIA

A. Manholes shall not include steps.

B. Manhole lids: Locking type.

C. Manhole bases:
   1. Constructed as part of the pipe installation or using tee risers.

D. Manhole riser:
   1. Made of the same pipe material selected for the project, providing a sealed connection between the pipe base and riser as indicated on the Drawings.
   2. Manufactured specifically for this project and no materials shall be furnished from stock unless approved by the Engineer.

E. Manhole provider shall coordinate with the pipe manufacturer for dimensions and connections.

F. Manhole systems:
   1. Provided by a single manufacturer.

G. Frames and covers:
   1. Provided by a single manufacturer unless approved by the Engineer.

1.06 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manholes: One of the following or equal.
   1. Oldcastle Infrastructure.

2.02 BASIS OF DESIGN

A. Design in accordance with local jurisdiction and Owner requirements, including but not limited to the following:
   1. Manhole frames and covers.
   2. Manhole diameter tolerance.
   3. Manhole length.
   4. Manhole cover bolting.
   5. Manhole backfill.

B. Structural design calculations:
   1. Load rating of manhole:
      a. Design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading.
   2. Resist buoyancy:
      a. Design with sufficient bottom anchorage and side friction to resist buoyancy.
      b. Depths will be as indicated on the Drawings.
      c. Refer to the geotechnical report for soil condition including fully saturated soil conditions.
      d. Concrete ballast:
         1) Pour sufficient concrete around tee-base pipe fitting and manhole riser base to prevent buoyancy in accordance with pipe manufacturer's recommendations.

C. Manholes, grade rings, risers, and bases:
   1. Manhole:
      a. Nominal sizes as indicated on the Drawings.
   2. Grade rings:
      a. At least 1 but not more than 2 grade rings shall be used.
      b. Maximum total distance from top of cone section to final grade: 18 inches.
   3. Cone and riser sections:
      a. As specified in this Section and as indicated on the Drawings.
      b. Cone sections shall be eccentric.

4. Manhole bases:
    a. As specified in this Section and as indicated on the Drawings.
    b. Provide corrosion protection system on unlined concrete.

D. Threaded lifting inserts:
1. Design inserts to be fully threaded:
    a. Do not fully penetrate through entire manhole wall.
2. Provide lifting device compatible with spreader bar and chains, hooks and slings.
3. Design with minimum safety factor of 4.0.
4. Do not use reinforcing steel bars.

2.03 MATERIALS

A. Cast iron manhole frames and covers.
1. In accordance with ASTM A48.
2. Covers: Bolted as specified.
3. Concrete collars: As indicated on the Drawings.

B. Manhole bases, risers, and grade rings:
1. Cement: Type II portland cement in accordance with ASTM C150.
2. Concrete aggregates: In accordance with ASTM C33, gradation as specified in approved mix design.
3. Sections: Steel reinforced.
4. Precast concrete sections: Manufactured by a process that will produce a dense, homogeneous concrete ring.
5. Top and bottom of sections: Parallel.

C. Joint sealant:
1. Preformed, cold applied flexible joint sealant in accordance with ASTM C990 and ASTM C443.
2. Manufacturers: One of the following or equal.
    a. Henry Corp., Ram-Nek.
    b. Kent Seal - Hamilton Kent Corp.

2.04 COMPONENTS

A. Pipe stubs:
1. Provide pipe stubs at manhole locations and in accordance with details indicated on the Drawings and as specified.
2. Plugging stubs:
    a. Plug stubs with vitrified clay stopper, brick plug, or other materials as indicated on the Drawings.
    b. Unless otherwise indicated on the Drawings, comply with following:
        1) Stubs up to and including 21 inches: Vitrified clay stoppers.
        2) Stubs greater than 21 inches: Brick plugs.

B. Resilient pipe connectors:
1. Unless otherwise indicated on the Drawings or specified, provide a flexible compression type connector between manhole and pipes entering and leaving the manhole in accordance with ASTM C923.
2. Resilient pipe connectors:
    a. Manufacturers: The following or equal.

1) A-LOK Premium.

C. Threaded lifting inserts.

D. Drop manholes:
1. Construct drop manholes at locations and in accordance with details indicated on the Drawings.
2. Provide inside diameter of drop inlet pipe the same as intercepted sewer unless otherwise indicated on the Drawings or specified in this Section.
3. Furnish and set fittings as indicated on the Drawings.

2.05 IDENTIFICATION MARKINGS

A. Identification marks on the exterior of bases, risers, grade rings, and include the following information:
1. Date of manufacture of the item.
2. Name or trademark of the manufacturer.
3. Internal diameter in inches.
4. Number of the manhole as indicated on the Drawings.

2.06 QUALITY CONTROL

A. Manufacturer to provide permanent quality control department and laboratory facility capable of performing inspections and testing as specified by this Section.

B. Material testing, inspection procedures, and manufacturing process are subject to inspection by the Owner or Owner's representative.

C. Perform manufacturer's tests and inspections in accordance with the referenced standards and as specified in this Section including the following:
1. Provide the Manufacturer's Certificate of Source Testing as specified in Section 01600 - Product Requirements.
2. Manufacturer shall make available services of representative throughout the project duration when deemed necessary by the Engineer.
3. Calibrate within last 12 months for equipment such as scales, measuring devices and calibration tools used in the manufacturing of pipe.
a. Each device used in the manufacture of manholes is required to have a tag recording date of last calibration.
b. Devices are subject to inspection by Engineer.

D. Furnish labor necessary to assist the Engineer in inspecting manholes upon delivery.

E. Remove rejected manholes immediately.

PART 3 EXECUTION

3.01 MANHOLE INSTALLATION

A. Excavate and backfill as specified in Section 02318 - Trenching and as indicated on the Drawings.

B. Maintain identification markings on installed pieces throughout installation.

C. Do not use sections with chips or cracks in the joint.

D. Engineer may inspect manhole sections, prior to installation.

E. Repair of manhole sections damaged during installation in accordance with manufacturer's repair procedures, with concurrence of Engineer.

F. Install joint sealant material in accordance with manufacturer's instructions:
   1. Completed manhole: Rigid and watertight.

G. Fill threaded lifting inserts with grout.

H. Lay grade rings on joint sealant with sides plumb and tops level.

I. Set frame and covers as specified and as indicated on the Drawings.

3.02 CLEANING

A. After completing each manhole, remove debris, construction materials, and equipment from the site of the work, grade, and smooth over the surface and leave the entire right-of-way in a clean, neat, and serviceable condition.

B. After completing each manhole, remove construction material debris from inside the manhole.

3.03 FUNCTIONAL TESTING

A. Provide materials for grouting and patching recommended by the manufacturer or an approved equal.

B. Vacuum testing in accordance with ASTM C1244.
   1. Install the vacuum test head on top of the manhole.
      a. Install and brace sealing devices on influent and effluent pipes.
   2. Draw a vacuum of 10 inches of mercury with a vacuum pump, deactivate the pump, and measure the actual elapsed time for the vacuum to drop to 9 inches of mercury.
   3. Compare test results with the minimum time requirements stated in the table below.
      a. If the actual elapsed time is less than the time in the table, the manhole is defective, and it shall be repaired and retested until it is acceptable.

Minimum Elapsed Time, Minutes: Seconds				
Manhole Depth, ft.	**Manhole Diameter, inches**			
	36	48	60	72
8	0:14	0:20	0:26	0:33
10	0:18	0:25	0:33	0:41
12	0:21	0:30	0:39	0:49

Minimum Elapsed Time, Minutes: Seconds				
Manhole Depth, ft.	**Manhole Diameter, inches**			
14	0:25	0:35	0:46	0:57
16	0:28	0:40	0:52	1:07
18	0:32	0:45	0:59	1:13
20	0:35	0:50	1:05	1:21
22	0:38	0:55	1:12	1:29
24	0:42	0:59	1:18	1:37
26	0:46	1:04	1:25	1:45
28	0:49	1:09	1:31	1:53
30	0:53	1:14	1:38	2:01

END OF SECTION

SECTION 02620

FILTER FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Nonwoven filter fabric.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   7. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Filter fabric: Nonwoven geotextile fabric manufactured from polypropylene fibers.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish filter fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Take field measurements to determine the lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex 401.
   2. Ten Cate Geosynthetics, Mirafi 140N.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property (1)	Test Method	Unit	Requirements (1)
Minimum Weight	ASTM D5261	oz	4.0
Grab Tensile Strength	ASTM D4632	lbs	100
Grab Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs	50
CBR Puncture Resistance	ASTM D6241	lbs	300
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	70
Permittivity	ASTM D4491	sec^{-1}	1.7
Flow Rate	ASTM D4491	gpm/ft^2	130
(1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of filter fabric.

3.02 PREPARATION

A. Surface preparation:
   1. During grading operations, take care not to disturb the subgrade.
   2. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the filter fabric smoothly without folds or wrinkles.

C. Use special care when placing the filter in contact with the soil so that no void spaces occur between the filter and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than manufacturer's instructions.

E. Do not drag filter fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers if necessary. Do not allow equipment directly on filter fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection:
   1. Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric.
   2. Repair all holes and rips by placing a new layer of fabric extending beyond the defect in all directions a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02621

STABILIZATION FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Woven stabilization fabric used for subgrade enhancement.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Stabilization fabric: Woven geotextile fabric manufactured from polypropylene yarns.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Installation Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish stabilization fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Field measurements:
   1. Take field measurements to determine the exact lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex 200ST.
   2. Ten Cate Geosynthetics, Mirafi 500X.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property (1)	Test Method	Unit	Requirements (1)
Grab Tensile Strength	ASTM D4632	lbs	200
Grab Elongation	ASTM D4632	%	15
Trapezoid Tear Strength	ASTM D4533	lbs	75
CBR Puncture Resistance	ASTM D6241	lbs	700
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	40
Permittivity	ASTM D4491	sec^{-1}	0.05
Flow Rate	ASTM D4491	gpm/ft^2	4
(1) Minimum average roll values.			

Property (1)	Test Method	Unit	Requirements (1)
Grab Tensile Strength	ASTM D4632	lbs	315
Grab Elongation	ASTM D4632	%	15
Trapezoid Tear Strength	ASTM D4533	lbs	120
CBR Puncture Resistance	ASTM D6241	lbs	900
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	40
Permittivity	ASTM D4491	sec^{-1}	0.05
Flow Rate	ASTM D4491	gpm/ft^2	4
(1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of stabilization fabric.

3.02 PREPARATION

A. Surface preparation: During grading operations, take care not to disturb the subgrade. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the stabilization fabric smoothly without folds or wrinkles.

C. Use special care when placing the stabilization fabric in contact with the soil so that no void spaces occur between the stabilization fabric and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than recommended by manufacturer.

E. Do not drag stabilization fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers, if necessary. Do not allow equipment directly on stabilization fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection: Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric. Repair all holes or rips by placing a new layer of fabric extending beyond the defect in all directions, a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02742

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Asphalt concrete pavement on prepared subgrade or aggregate base course, and on existing pavement, to lines, grades, compacted thicknesses, and cross sections indicated on the Drawings.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Transportation Materials and Methods of Sampling and Testing:
      a. MP1: Specification for Performance Graded Asphalt Binder.

B. ASTM International (ASTM):
   1. C117 - Standard Test Method for Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D977 - Standard Specification for Emulsified Asphalt.
   5. D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   6. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. Utah Department of Transportation (UDOT):
   1. Standard Specifications for Road and Bridge Construction (Standard Specifications).

1.03 DEFINITIONS

A. Bituminous prime coat: Consist of application of hot bituminous material on previously prepared base course.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Compact the asphalt concrete to at least 95 percent of the density of the theoretical maximum density in accordance with ASTM D2041.

1.05 SUBMITTALS

A. Proposed mix design and gradation of materials.

B. Quality control submittals:
   1. Certificate of Compliance.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Asphalt concrete delivery:
   1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of all foreign materials.
   2. Treat bodies as necessary to prevent material from sticking to the bodies.
   3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

B. Comply with **Owner** storage requirements.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Asphalt concrete:
      a. Place asphalt concrete only when surface is dry, and when atmospheric temperature in the shade is 40 degrees Fahrenheit and rising, or above 50 degrees Fahrenheit if falling.
      b. Do not place asphalt concrete when weather is foggy or rainy or when base on which material is to be placed is in wet or frozen condition.
   2. Prime coat:
      a. Do not apply prime coat when atmospheric temperature is below 60 degrees Fahrenheit.
      b. Apply prime coat only when base course is dry or contains moisture not in excess of that which will permit uniform distribution and desired penetration.

1.08 SEQUENCING AND SCHEDULING

A. Prime coat:
   1. Prior to requesting Engineer's acceptance for application, inspect area to be coated to determine its fitness to receive bituminous priming material.
   2. Do not begin application before area to be coated has been accepted for application by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Subgrade material: Stabilization material as specified in Section 02050 - Soils and Aggregates for Earthwork.
   1. Thickness: As indicated on the Drawings.
   2. Maximum lift thickness: 4 inches.
   3. Compaction: Minimum 98 percent of the AASHTO T-180 maximum dry density.

B. Base material: Aggregate base course material as specified in Section 02050 - Soils and Aggregates for Earthwork.
   1. Thickness: As indicated on the Drawings.

a. Maximum lift thickness: 4 inches.
2. Compaction: Minimum 98 percent of the AASHTO T-180 maximum dry density**.**

C. Prime coat:
1. Use bituminous material for prime coat in accordance with SC-70**.**
2. Apply at temperature of 105 to 175 degrees Fahrenheit at rate of 0.3 to 0.6 gallons per square yard by use of bituminous distributor.

D. Sand: Acceptable to the Engineer.

E. Tack coat: Grade SS-1h cationic emulsion in accordance with ASTM D977.

F. Asphalt concrete materials:
1. Asphalt cement: Conform to requirements for asphalt cement, PG 64-34 AASHTO MP1.
2. Mineral aggregate:
a. Consist of coarse aggregate of crushed stone or gravel composed of hard, durable particles, sand, and filler as follows:
1) Coarse aggregate: Portion of material retained on Number 8 sieve. Fine aggregate: That portion passing Number 8 sieve.
b. Provide composite material that is uniformly graded from coarse to fine and that complies with requirements of one of following gradings when tested in accordance with ASTM C136.
c. Asphalt concrete: As indicated on the Drawings, 2-course plant mix for asphalt concrete having an overall thickness of 2 1/2 inches or more if not indicated. If less than 2-1/2 inches of asphalt concrete, use single-course plant mix.

Plant Mix, Two Course			
Seal, 3/4 inch Thick Minimum		**Base, 1-3/4 inch Thick Minimum**	
Sieve Size	**Percent Passing**	**Sieve Size**	**Percent Passing**
1/2"	100	1-1/4"	100
3/8"	95 - 100	1"	87 - 100
No. 4	50 - 70	3/4"	75 - 90
No. 8	35 - 55	3/8"	55 - 72
No. 30	15 - 30	No. 4	40 - 60
No. 100	5 - 15	No. 8	30 - 50
No. 200	3 - 8	No. 30	15 - 30
		No. 100	5 - 15
		No. 200	3 - 8

3. Coarse aggregate:
    a. Consist of at least 70 percent by weight of each size aggregate and consist of particles that have at least 1 rough, angular surface produced by crushing:
        1) Have percentage of wear of not more than 50 at 500 revolutions, in accordance with ASTM C131.
    b. Aggregate plasticity index: Not more than 2 in accordance with ASTM D4318.
    c. Sand may be added to crusher or pit-run product to supply any deficiency in Number 8 sieve and filler may be added to supply any deficiency in Number 200 sieve material. If aggregate contains an excess of sand, wasting will be required.
    d. Filler:
        1) Use finely powdered limestone, portland cement, or other artificially or naturally powdered mineral dust acceptable to the Engineer.
        2) Weigh filler and add separately to each batch at time of proportioning.
        3) Use filler that is free from deleterious matter of any kind.
        4) Fineness that meet the following requirements:
            a) Passing Number 50 sieve: 100 percent.
            b) Passing Number 200 sieve: At least 75 percent.
        5) Determine amount of material passing the Number 200 sieve in accordance with ASTM C117.
    e. Provide composite aggregate that is free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter which would prevent thorough coating of asphalt cement.
    f. Materials derived from processing demolished, or removed asphalt concrete, are not acceptable.

2.02 EQUIPMENT

A. Bituminous distributor: Designed and equipped so as to distribute bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rate with pressure range of 25 to 75 pounds per square inch.

B. Liquid asphalt distributor:
    1. Designed and operated to distribute asphaltic material in uniform spray without atomization.
    2. Equipped with bitumeter having dial registering feet of travel per minute.
        a. Locate dial so that it is visible to truck driver so that he can maintain constant speed required for application at specified rate.
    3. Equip pump with tachometer having dial registering gallons per minute passing through nozzles.
        a. Locate dial so that it is readily visible to operator.
    4. Provide means for accurately indicating temperature of asphaltic material in distributor at all times.
        a. Locate thermometer well so that it is not in contact with, or close to, heating tube.
    5. Have spray bar having normal width of application of not less than 12 feet and capable of providing for application of lesser width when necessary.
    6. Provided with hose and spray nozzle attachment for applying asphaltic material to patches and areas inaccessible to spray bar.

7. Equipped with heating attachments and capable of circulating asphaltic material through spray bar during entire heating process.

C. Asphalt concrete mixing plants:
   1. Equipment:
      a. Use screen and storage bins at plant of sufficient capacity to furnish the necessary amount of all aggregates, when operating at the maximum capacity of the plant, with no periods of undue waiting for material.
         1) Use bins consisting of at least 2 compartments, so proportioned as to ensure adequate storage of appropriate fractions of the aggregate.
         2) Provide each compartment with an overflow pipe of such size and at such location as to prevent any backing up of material into other compartments.
      b. Dryer:
         1) Designed to heat and dry the aggregate to Specification requirements and to agitate it continuously during the heating.
         2) Capable of preparing aggregates at a rate equal to the full-rated capacity of the plant.
      c. Dust collector:
         1) So constructed as to waste or return uniformly to the hot elevator all or any part of the material collected.
      d. Mixer:
         1) Adequate capacity, with twin shafts.
      e. Thermometers:
         1) Furnished for determining the temperature of the mix.
      f. Weighing and measuring equipment:
         1) Weighing or volumetric measuring equipment of sufficient capacity.
         2) Devices to permit easy readjustment of any working part needing readjustment, so that the equipment will function properly and accurately.
         3) Attach scales for weighing to the bucket.
         4) Test and seal all weighing equipment by a representative of the Inspector of Weights and Measures having jurisdiction, as often as the Engineer may deem necessary to ensure accuracy.
      g. Tanks for storage of bituminous material:
         1) Capable of heating the material under effective and positive control at all times to temperatures within the range stipulated.
   2. Asphalt concrete plant operation:
      a. Mineral aggregate:
         1) Dry and heat mineral and then screen into at least 2 fractions and conveyed into separate compartments ready for proportioning and mixing.
         2) When combined with asphalt cement:
      b. Aggregate:
         1) Contain not more than 2 percent moisture by weight.
         2) Be at a temperature within the range of that specified for the asphalt cement but not more than 25 degrees Fahrenheit above the temperature of the asphalt cement.
      c. Combine dry aggregate in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading.
         1) Introduce the asphalt cement into the mixer in the amount and at the temperature for the particular material being used.

2) Continue mixing for at least 30 seconds, and for such longer period as may be necessary to coat all the particles.

d. When a continuous mixer is used, determine the mixing time by weight method using the following formula:
   1) Mixing time in seconds = Pugmill dead capacity in pounds.
   2) Pugmill output in pounds per second.

D. Asphalt-concrete-placing equipment:
   1. Use equipment for placing, spreading, shaping, and finishing asphalt concrete consisting of a self-contained power machine operating in such manner that no supplemental spreading, shaping, or finishing is required to provide surface that complies with requirements for smoothness contained in this Section.
      a. In areas inaccessible to the machine, hand spreading may be permitted.
   2. Furnish 1 self-propelled, pneumatic-tired roller, and one 8-ton (minimum), smooth-wheel tandem roller.
      a. When spreading is in excess of 100 tons per hour, furnish 1 additional roller of either type for each additional 100 tons, or fraction thereof, spread per hour.

2.03 MIXES

A. Asphalt cement:
   1. Do not mix at temperatures lower than 275 degrees Fahrenheit or higher than 325 degrees Fahrenheit.
   2. Usual amount of asphalt cement, by weight, to be added to aggregate be 5.4 to 5.8 percent of weight of mixture.

B. Asphalt concrete:
   1. Before being delivered to the site, mix aggregate with asphalt cement at the central mixing plant.
   2. Use mixing plants that are in good working order with no excessively worn parts and so equipped that:
      a. Temperatures of aggregates leaving dryer, of asphalt cement entering mixer, and of mix leaving mixer can be readily determined and positively controlled within Specification limits at all times.
      b. Weights of different sizes of aggregates and of asphalt cement as set by the Engineer can be consistently introduced into the mixer.
      c. Asphalt cement can be uniformly distributed throughout the mixture with aggregate completely coated.
      d. Mixing time can be positively controlled to minimum specified.
      e. Bin samples of aggregate can be readily obtained.
      f. Provide means of calibrating weighing devices.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection
   1. Prime-coated surfaces:
      a. Maintain surfaces until succeeding layer of pavement has been placed.
      b. During this interval, protect primed surfaces against damage and repair any broken spots.

B. Surface preparation:
   1. Prime coat:
      a. Where portions of base course prepared for immediate treatment are excessively dry, sprinkle such portions lightly with water immediately in advance of prime coat application.
      b. Immediately following preparation of base course, apply bituminous material by means of bituminous distributor at the temperature previously specified.
      c. Apply priming material in manner that results in uniform distribution being obtained at all points of surface to be primed.
      d. Following the application of prime material, allow the surface to dry for a period of not less than 48 hours without being disturbed, or for such additional period of time as may be necessary to obtain penetration into the base course and drying out or evaporation of the volatiles from prime material.
      e. Spread sufficient sand on areas that show an excess of bituminous material to effectively blot up and cure the excess.
   2. Base courses:
      a. Thoroughly clean base and apply prime coat before placing asphalt concrete.
      b. Thoroughly clean any existing base, surfacing, or pavement prior to placing plant-mixed surfacing.
      c. Where existing pavement is being widened or extended, cut to straight vertical face and treat with asphalt paint binder prior to paving operations.
      d. When asphalt concrete is to be applied over existing pavement and local irregularities in existing surface would result in course of more than specified thickness, bring surface of existing pavement to uniform contour by patching with asphalt concrete thoroughly tamped or rolled until it conforms with surrounding surface, and then apply tack coat.

3.02 APPLICATION

A. At existing asphalt to be paved over: Apply tack coat at minimum rate of 0.10 gallons per square yard.

B. Placing and compacting asphalt concrete:
   1. Placing and compacting asphalt mixture: Progress in sections generally not more than 750 linear feet in length.
   2. Spreading of mixture:
      a. Spread, shape, and finish by specified equipment.
      b. Spread each successive strip adjacent to previously spread strip.
      c. Do not compact minimum 6-inch width of each strip adjacent to new strip until after new strip has been placed.
      d. Spread as nearly continuous as possible.
      e. Laying against vertical surfaces such as gutters: Roughen and clean face of vertical surfaces as required for proper bonding and then paint with light coating of asphalt cement or emulsified asphalt.
      f. At terminations of new surface courses: Feather asphalt mixture into existing surface over such distance as may be required to produce smooth riding transition.
      g. Base-course and single-course construction: Joined by vertical butt joints, finished and rolled to smooth surface.

h. Rolling:
1) Perform initial or "breakdown" rolling with tandem power roller and follow spreading operation when mixture has reached temperature where it does not "pick up" on rolls.
2) Keep rolls properly moistened but do not use surplus of water.
3) Follow initial rolling with pneumatic roller when mixture is in proper condition and when rolling does not cause undue displacement, cracking, or shoving.
4) Begin rolling at sides and progress gradually to center, lapping each preceding track until entire surface has been rolled.
5) Terminate alternate trips of roller in stops at least three feet distant from any preceding stop.
6) At any place not accessible to roller, thoroughly compact mixture with tampers and finish, if necessary, with hot iron to provide uniform layer over entire width being paved.

3. Provide finish surface having uniform texture.

C. Full-depth asphalt pavement:
1. Contractor's option:
a. Install either asphalt and aggregate base material or full-depth asphalt pavement in areas where paving is indicated on the Drawings or specified to be 2 inches of asphalt concrete over aggregate base course.
b. If option is selected to install full-depth asphalt pavement, prepare subgrade as previously specified in this Section.
c. Substitute asphalt concrete for aggregate base at ratio of 1 inch of asphalt concrete to 2-1/2 inches of aggregate base material. Use full-depth asphalt pavement not less than 4 inches in thickness after compaction.
d. Place asphalt concrete in courses of not more than 4 inches.
e. Use compaction equipment in accordance with following course thicknesses:
1) 1- to 2-inch thickness: Minimum 8-ton roller.
2) 2- to 3-inch thickness: Minimum 10-ton roller.
3) 3- to 4-inch thickness: Minimum 12-ton roller.

2. Pneumatic rollers used for initial or secondary rolling: Use 12 to 15 tons with tires capable of 90-pounds-per-square-inch inflation pressure.
3. Asphalt concrete for full-depth asphalt pavement:
a. Asphalt concrete as previously specified in this Section.
b. Apply bituminous prime coats where full-depth asphalt pavement is installed.
c. Contractor's option: If Contractor elects to use full-depth asphalt pavement, at road shoulders reduce aggregate base course to minimum aggregate thickness of 4 inches.

4. Except for asphalt thickness, aggregate base course thickness, and prime coating, full-depth asphalt pavement shall comply with requirements of this Section.

3.03 FIELD QUALITY CONTROL

A. Base course density tests:
1. Density tests shall be taken at locations suitable to confirm compliance with compaction requirements.
2. Take a minimum of 1 test per 1,000 square yards, for each lift.

B. Placement:
   1. Place the mixture on the roads, pavements, or walks at a temperature not less than 225 degrees Fahrenheit.

C. Curing time:
   1. Allow asphalt concrete to cure for the following time periods:
      a. Minimum 24 hours before foot traffic is allowed.
      b. Minimum 5 days before vehicle traffic is allowed.
      c. Minimum 10 days before overnight parking is allowed.
      d. Minimum 20 days before heavy construction vehicle traffic is allowed.
   2. Contractor shall provide barricades and signs as required to enforce curing time.

D. Asphalt tests:
   1. Provide sampling and control testing for the asphalt concrete.
      a. Location, type, and size of the samples: Suitable to determine conformance with stability, density, thickness, compaction, and other specified requirements.
      b. Use an approved power saw or core drill for cutting samples.
      c. Furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed.
      d. Take a minimum of 1 sample per 200 tons of asphalt concrete placed.

E. Inspection:
   1. Asphalt concrete:
      a. Test with a 10-foot straightedge laid on the surface parallel with the centerline of the road. Variation of the surface from the testing edge of the straightedge not to exceed 1/4 inch.
      b. Test each course with running water applied on the surface of the pavement. Water shall flow in the direction indicated on the Drawings. After stopping the water, the pavement surface shall have no areas with standing water.

END OF SECTION

SECTION 02939

SEEDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Seeding.
   2. Hydromulching.
   3. Erosion-control material(s).

1.02 REFERENCES

A. Association of Official Seed Analysts (AOSA).

B. United States Department of Agriculture (USDA).

C. United States Environment Protection Agency (EPA).

1.03 DEFINITIONS

A. Duff layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish grade: Elevation of finished surface of planting soil.

C. Manufactured topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Surface soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 SUBMITTALS

A. Product data: For each type of product indicated:
   1. Pesticides and herbicides: Include product label and manufacturer's application instructions specific to this Project.
   2. Fertilizer and organic matter: Include product label and manufacturer's application instructions specific to this Project.
   3. Soil amendment: Analysis.

B. Certification of grass seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification and inspection as required by governmental authorities of each seed mixture for Native Shortgrass Mix. Include identification of source and name and telephone number of supplier.

C. Qualification data: For qualified landscape Installer.

D. Samples: Imported topsoil, organic matter, erosion control blanket and mulch.

E. Product certificates: For soil amendments and fertilizers, from manufacturer.

F. Maintenance instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

1.05 QUALITY ASSURANCE

A. Installer qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.
   1. Professional membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: 5 years' successful experience in the installation of seeded areas similar in size to this project.
   3. Installer's field supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
      a. Certified Landscape Technician - Exterior, with installation and irrigation specialty area(s).
   5. Maintenance proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site.
   6. Pesticide applicator: State licensed, commercial.

B. Soil-testing laboratory qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience

and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil. Refer to plan notes for number and location of soil analysis tests.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Engineer.
      a. A minimum of 3 representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for turf growth.
      a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated.
         1) State recommendations in weight per 1,000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation conference: Conduct conference at project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Seed and other packaged materials:
   1. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
   2. Protect seed during delivery and storage.
   3. Seed that has become wet or otherwise damaged will not be acceptable.

B. Deliver packaged materials in waterproof bags showing weight, chemical analysis and name or trademark of manufacturer.
   1. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, percentage of purity (PLS), percentage of germination and location of packaging.

C. Local sourcing of seed not in sealed containers is permitted for smaller projects.

D. Label seed bags per variety.

E. Store materials in protected and covered storage until application or use.

F. Bulk materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

G. Truck receipts: For verification of all soil amendments and imported topsoil.

1.07 SITE CONDITIONS

A. Planting restrictions: Plant during 1 of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date.
1. Irrigated seed areas: Seed from ground thaw to July 31 and September 1 to October 15.
2. Non-irrigated seed areas: Seed from March 15 to July 4 and September 1 to October 15.
3. Pure Warm Season Grass Seed Areas: Seed from June 1 to August 15.
4. Dormant Seeding Areas: Seed from October 15 to ground freeze.
5. Per seed detail.

B. Coordinate with Contractor’s work requiring access to site over existing vegetation areas.
1. No trucking or moving of equipment or materials shall be permitted over completed seed areas.

C. Coordinate with installation of all underground system piping and outlets.

D. Weather limitations:
1. Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.
2. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.08 WARRANTY

A. Warranty:
1. Guarantee all seeding to be alive and healthy for 1 years following date of final completion by the Engineer.
2. Seeded areas shall have an even stand of grass with germination, over 100 percent of the site within 45 days of seeding.
3. All seeded grass areas are to be ensured of obtaining a satisfactory stand of growth.
4. The total area occupied by bare spots larger than 0.25 square feet must not exceed 10 percent of the total seeded area.
5. Maximum single bare spot size of irrigated seed 3 inches by 3 inches.
6. Maximum single bare spot size of non-irrigated seed is 1 square foot.
7. All seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.

B. Replace seeding when it is no longer in a satisfactory condition or do not meet the preceding standard as determined by the Engineer or the duration of the Guarantee/Warranty Period.

1. Make replacements as soon as possible within the recommended seeding schedule.

C. Replacements:
   1. Seed of same mix, quality and species as originally specified, as soon as possible within the recommended seeding schedule, with a new 1-year warranty commencing on date of replacement.
   2. Repairs and replacements shall be made at no expense to the Owner.

PART 2 PRODUCTS

2.01 HYDRO-MULCH SEEDING

A. The planting mixture shall consist of a 4:1:6 mixture of wood cellulose fiber, seeds and fertilizer in the ratio of 20 pounds of fiber, 5 pounds of seeds and 30 pounds of fertilizer, per 1,000 square feet.

B. Modify mixture according to the planting season as follows:
   1. February through August: 20 pounds of hulled common Bermuda grass per acre.
   2. August through February: Combination of 15 pounds of unhulled common Bermuda and 15 pounds of unhulled Gulf Coast Annual Rye seed per acre.

C. Provide a recommendation for proposed mixture based on time of year hydro-mulch is actually performed.

2.02 HYDROMULCHING EQUIPMENT

A. Manufacturers: One of the following or equal:
   1. Bowie Industries, Inc.
   2. Reinco.
   3. Finn Equipment Co.

B. With built-in agitation system sufficient to agitate, suspend, and homogeneously mix slurry containing fiber, fertilizers, chemicals, and seed mix.

C. Capable of slurry distribution line large enough to prevent stoppage.

D. Equipped with set of hydraulic spray nozzles which provide continuous nonfluctuating discharge of minimum 225 pounds per square inch at end of spray nozzle.

2.03 GRASS SEED

A. Grass seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed species:
   1. Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed.

2. The percentage of material, other than grass seed in the mixture, shall not include more than 18 percent non-viable seed, chaff, hulls, live seed of crop plants (other than those specified), harmless inert matter.

C. Provide seed mixes per seed as indicated on the Drawings.

2.04 EROSION CONTROL SEED

A. Erosion control seed mix from latest crop. Minimum pure live seed content to be 80 percent and tested within the preceding 6 months. Do not use seed mix after expiration date.
   1. Blando Brome: 20 pounds per acre.
   2. Annual Rye: 25 pounds per acre.
   3. Rose Clover: 20 pounds per acre.
   4. Zorro Annual Fescue: 10 pounds per acre.

2.05 SOIL AMENDMENTS

A. Soil amendments and fertilizer shall be applied as indicated on the Drawings unless imported topsoil is used.
   1. Soil amendment and fertilizer recommendations, along with supporting soil test analysis, shall be submitted to and approved by the Engineer prior to application on the site.

2.06 FERTILIZERS

A. Uniform in composition, free flowing and suitable for application with approved equipment, of the proportions necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
   1. Fertilizer shall be delivered to the site fully labeled according 10 applicable state fertilizer laws and shall bear the name, tradename, trademark and warranty of the provider.

B. As indicated on the Drawings and notes.

2.07 PLANTING SOILS

A. Topsoil: Fertile soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, stones over 1 inch in diameter, clay clumps, or impurities, plants weeds and roots; pH value of minimum 6.5 and maximum 7.5.

B. Stockpiled on-site topsoil free of subsoil, stones over 1 inch in diameter, clay clumps, or impurities, plants, weeds and roots.

2.08 MULCHES

A. Mulching material:
   1. Straw mulch:
      a. Straw of oats, barley, wheat or rye only.
      b. Straw shall be free from weeds, foreign matter detrimental to plant life, and dry. 50 percent of straw shall be minimum 10 inches long.
      c. Hay or chopped cornstalks are not acceptable.

d. Straw in such an advanced stage of decomposition as to smother or retard the normal growth of grass will not be accepted.
e. Old straw mulch which breaks during crimping will not be accepted.

2. Wood cellulose fiber mulch:
a. Wood cellulose fiber mulch, containing no substance or factor which might inhibit germination or growth of grass seed, with organic tacilier.
b. Wood fibers must be capable of being evenly dispersed and suspended when agitated in water.
c. Furnish dyed wood cellulose fiber with green color to allow visual metering of its application.

3. As indicated on the Drawings.

B. Hydroseeding Mulch: Wood fiber manufactured for hydroseeding:
1. Manufacturers: One of the following or equal:
a. Grass Growers.
b. Conwed Corp., Fibers Div.
c. Eva Cell Co.

C. Erosion control blanket:
1. Jute matting, open weave.
2. Excelsior erosion control blankets or approved equal:
a. Regular blanket, machine produced mat of curled wood excelsior of 80 percent 6 inch or longer fiber length with a consistent width of fibers evenly distributed throughout mat; a photo-biodegradable extruded plastic netting shall cover the top side of blanket.
b. Netting shall be secured to wood excelsior by extra heavy lines of plastic woven into the width of each blanket.
c. Blanket shall be smolder resistant with no chemical additives.

3. As indicated on the Drawings.

D. Herbicide and pesticide: Submit labels for approval.

E. Stakes: Softwood lumber, chisel pointed.

2.09 PESTICIDES

A. General:
1. Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application.
2. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-emergent herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-emergent herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
   3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Start of work covered in this Section constitutes Contractor's approval of all existing site conditions.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by the Engineer and replace with new planting soil.

3.02 PREPARATION

A. Protect existing and new structures, fences, utilities, sidewalks, paving, curbs, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.
   3. Protect landscaping and other features remaining as final work.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly graded subgrades:
   1. Loosen/scarify subgrade to a minimum depth of 6 inches.
   2. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   3. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted the subgrade.
   4. Tolerances: Top of subgrade plus or minus 1 inch.

C. Prepare subgrade and eliminate uneven areas and low spots.

1. Maintain lines, levels, profiles and contours.
2. Make changes in grade gradual. Blend slopes into level areas.

D. Do not prepare subgrade in areas of on-site plant preservation.

E. Do not bury foreign material beneath areas to be seeded.

F. Remove any contaminated subgrade.
   1. Apply superphosphate fertilizer directly to subgrade before loosening.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      b. Mix lime with dry soil before mixing fertilizer.
   2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
      b. Reduce elevation of planting soil to allow for soil thickness of sod.

G. Unchanged subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf.
      a. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least 6 inches.
      a. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil.
      b. Apply superphosphate fertilizer directly to surface soil before loosening.
   3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including contaminated soils, grass, vegetation, and turf, off Owner's property.

H. Finish grading:
   1. Grade seeding areas to a smooth, uniform surface plane with loose, uniformly fine texture.
   2. Grade to within plus or minus 1/2 inch of finish elevation.
   3. Roll and rake, remove ridges, fill depressions to meet finish grades, and ensure positive surface drainage.
   4. Maintain profiles and contour of subgrade.
   5. Limit finish grading to areas that can be planted in the immediate future.

I. Rip topsoil that has been spread to a minimum depth of 8 inches in one direction using an agricultural ripper with tines spaced at no greater than 18 inches.
   1. Areas adjacent to walks, structures, curbs, etc., where the use of large mechanical equipment is difficult, shall be worked with smaller equipment or by hand.

J. Manually spread topsoil close to plant materials and structures to prevent damage.

K. Spread amendments, as determined by the soil test results or indicated on the Drawings, over the entire area to be seeded and incorporate into the top 6 inches of

soil by disking or rototilling until a uniform mixture is obtained with no pockets of soil or amendments remaining.

L. Restore fine grade with float drag to remove irregularities resulting from tilling operations.
   1. Float drag or rake in 2 directions.
   2. Remove any additional stones over 1 inch that have come to the surface.
   3. Perform drainage test by applying water with the irrigation system.
   4. Do not plant until the finished grade is reviewed by the Engineer.
   5. This review does not reduce Contractor's responsibility to provide a finished product that drains.

M. Apply fertilizer, if necessary, after smooth raking of topsoil and prior to planting of seed.
   1. Apply fertilizer at a rate as determined by the soil tests or indicated on the Drawings.
   2. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
   3. Mix thoroughly into upper 6 to 8 inches of soil.

N. Lightly water to aid the dissipation of fertilizer.

O. Remove any additional stones over 1 inch that have come to the surface.

P. Moisten prepared area before planting if soil is dry.
   1. Water thoroughly and allow surface to dry before planting.
   2. Do not create muddy soil.

Q. Before planting, obtain Engineer’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

R. Tolerances: Top of topsoil plus or minus 1/2 inch.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Install erosion-control materials in accordance with manufacturers recommendations.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions.
   1. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry.
   1. Water thoroughly and allow surface to dry before planting.
   2. Do not create muddy soil.

3.05 HYDROSEED WATERING

A. Provide temporary watering system or apply water with a water truck acceptable to Engineer.
   1. Plant effluent may be used for hydroseed watering.
   2. Do not place irrigation lines on top of embankment slope.

B. Germination Stage:
   1. Initiate watering sequence within 24 hours after hydromulching planted areas. Leave water on long enough to moisten soil thoroughly to a depth of the fiber, taking care not to supersaturate or wash fiber or soil particles off the slopes. Observe irrigation system continually while in operation.
   2. Contractor to repair all seed washing or erosion immediately.
   3. Irrigate fiber and seed lightly and frequently to maintain optimum moisture content for maximum germination. Determine irrigation sequence according to air temperature, prevailing wind velocity, soil texture, orientation, and other logistical problems.
   4. Keep soil moist at all times during germination period. Continue irrigation sequence until seedlings have grown beyond the germination stage, approximately 30 to 60 days.

C. Establishment Stage:
   1. Reduce watering frequency while increasing duration of the water sufficiently to allow for maximum water penetration for the expanding root system. Take care not to cause erosion.
   2. Precise watering reduction program to be determined by Contractor.

D. Hardening-off Stage:
   1. Reduce irrigation frequency while increasing the duration of each water cycle.
   2. A specific watering program to be approved by Owner.

3.06 HYDROSEED MOWING

A. Contractor to mow seeded areas prior to spring germination.

3.07 HYDROSEED MAINTENANCE

A. Maintain hydroseed areas for 1 year following final acceptance.

B. Maintenance involves watering, mowing, and any other activities required to establish and maintain the ground cover.

3.08 SEEDING

A. Preparation for seeding:
   1. Prior to seeding, if weeds exists, apply Round-Up herbicide per manufacturer's specifications after germination of weed seeds and at least 2 weeks prior to seeding.
   2. Do not spray on a day when wind is detectable.
   3. Remove remaining vegetative matter.
   4. Repeat herbicide application until no weeds are evident for 14 days after last herbicide application, as determined by the Engineer.

B. Drill seeding:
   1. Drill seed by means of a Brillion mechanical power-drawn drill seeders, or equal, to a maximum depth of 1/4-inch followed by packer wheels or drag chains to provide smooth finish.
   2. Seed at the rates given below.
   3. Seed in 2 passes at right angles to one another.
   4. Sow half the seed in each pass.

5. Provide markers or other means to ensure that the successive seeded strips will overlap or be separated by a space no greater than the space between the rows planted by the equipment being used.
6. Do not seed during windy weather.
7. Restore fine grade after seeding as requested by the Engineer.
8. Remove irregularities by hand raking or rolling.

C. In areas inaccessible to a drill seeder, broadcast seed by hand in 2 opposite directions.
1. Rake in seed after broadcasting.
2. Do not broadcast seed during windy weather.

D. Seeding rates:
1. Seeding rates shall be as indicated on the Drawings for drill seeded areas.
2. Hand and broadcast seeded areas shall receive 2 times the seeding rate indicated.

E. Do not seed areas in excess of that which can be mulched on same day.

F. Do not sow immediately following rain, when ground is too dry, frozen, or during windy periods.

G. Roll seeded area with roller not exceeding 100 pounds.

H. Immediately following seeding and compacting, apply mulch.

I. Sow seed with spreader or seed drill machine.
1. Do not broadcast or drop seed when wind velocity exceeds 5 miles per hour.
2. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
a. Do not use wet seed or seed that is moldy or otherwise damaged.
b. Do not seed against existing trees.
1) Limit extent of seed to outside edge of planting saucer.

J. Sow seed at a total rate as indicated on the Drawings.

K. For any Broadcast seeded areas rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

L. Protect seeded areas with erosion-control mats where indicated on the Drawings; install and anchor according to manufacturer's written instructions.

3.09 SEED ESTABLISHMENT ON SLOPES

A. Protect seeded areas with slopes and swales exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

B. Roll fabric onto slopes without stretching or pulling.

C. Lay fabric smoothly on surface in direction of water flow.
1. Bury top end of each section in 6-inch deep excavated topsoil trench.
2. Provide 6-inch overlap of adjacent rolls.
3. Backfill trench and rake smooth, level with adjacent soil.

D. Secure outside edges and overlaps at 24-inch intervals with stakes.

E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

F. For sides of ditches, lay fabric laps in direction of water flow.
   1. Lap ends and edges minimum 6 inches.

3.10 MULCHING

A. Straw mulching:
   1. After seeding, apply 2 tons of small grained straw per acre.
      a. Spread straw to give a 1/2-inch to 1-inch thick layer of mulch (3 to 5 straws thick) and crimp in 2 to 3 inches with a mechanical crimper or other approved equipment.
   2. Hand crimping shall be employed in areas inaccessible to crimper, or where excessive slopes would cause unsatisfactory results.
   3. Crimping against the contour shall not be accepted.
   4. Apply water and tackifier with a fine spray immediately after each area has been mulched.
      a. Saturate to 4 inches of soil.

B. Hydromulching:
   1. Hydromulch all dormant seeded areas with a slurry mix containing additional tacifier.
   2. Utilize hydraulic equipment with nozzle adapted for hydraulic mulching with storage tanks having means of estimating volume used or remaining in the tank.
   3. Hydromulch shall consist of tacifier applied at a rate of 100 pounds per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,200 pounds per acre.
      a. Hydromulch applied to dormant seeded areas shall consist of tacifier applied at a rate of 150 pounds per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,200 pounds per acre.

C. Protect seeded areas with slopes not exceeding 1:4 by spreading straw mulch.
   1. Spread uniformly at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.
   2. Spread by hand, blower, or other suitable equipment.
      a. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
      b. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gallons per 1,000 square feet.
         1) Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas.
         2) Immediately clean damaged or stained areas.

D. Protect seeded areas from hot, dry weather or drying winds by applying hydro mulch and tackifier within 24 hours after completing seeding operations.
   1. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

3.11 EXISTING VEGETATION RENOVATION

A. Renovate existing vegetation.

B. Renovate existing vegetation damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish vegetation where settlement or washouts occur or where minor regrading is required.
   2. Install topsoil as required.

C. Remove sod and vegetation from diseased or unsatisfactory vegetation areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing vegetation.

F. Prior to seeding, irrigate for a minimum of 2 weeks to allow germination of weed seeds.
   1. Apply Round-Up herbicide per manufacturer's specifications after germination of weed seeds and at least 2 weeks prior to seeding.
   2. Do not spray on a day when wind is detectable.
   3. Remove remaining vegetative matter.
   4. Repeat irrigation and herbicide application until no weeds are evident for 14 days after last herbicide application, as determined by the Engineer.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil.
   1. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with hydro mulch as required for new vegetation.

K. Water newly planted areas and keep moist until new turf is established.

3.12 SATISFACTORY SEED AREAS

A. Turf installations shall meet the following criteria as determined by the Engineer:
   1. Acceptance for soil preparation (topsoil installation) and final grading shall be given by the Engineer upon satisfactory completion of each section or area prior to seeding as indicated on the Drawings or as otherwise specified.
   2. Final completion for seeded areas shall be given by the Engineer as soon as there is an even stand of grass with germination over 100 percent of the site.
      a. Warranty:
         1) Guarantee all seeding to be alive and healthy for 2 years following date of final completion by the Engineer.

2) Seeded areas shall have an even stand of grass with germination, over 100 percent of the site within 45 days of seeding.
3) All seeded grass areas are to be ensured of obtaining a satisfactory stand of growth.
4) The total area occupied by bare spots larger than 0.25 square feet must not exceed 10 percent of the total seeded area.
5) Maximum single bare spot size of irrigated seed 3 inches by 3 inches.
6) Maximum single bare spot size of non-irrigated seed is 1 square foot.
7) All seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.

b. Re-seed areas that in the opinion of the Engineer do not meet the preceding standards.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.13 SEEDED AREA MAINTENANCE

A. Maintain and establish seeded area by watering, noxious weed management, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable seeded area.
1. Roll, regrade, and replant bare or eroded areas and remulch.
2. Provide materials and installation the same as those used in the original installation.
a. Fill in as necessary soil subsidence that may occur because of settling or other processes.
1) Replace materials and seeded area damaged or lost in areas of subsidence.
b. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
c. Apply treatments as required to keep seeded area and soil free of pests and pathogens or disease.
1) Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and seeded area watering equipment to convey water from sources and to keep meadow uniformly moist.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
a. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water meadow with fine spray at a minimum rate of 1/2 inch per week or more for seed establishment for 6 weeks after planting or until seed establishment is determined by the Engineer (whichever is longer) unless rainfall precipitation is adequate.

3.14 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations.
   1. Coordinate applications with Owner's operations and others in proximity to the Work.
   2. Notify Owner before each application is performed.

B. Post-emergent herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.15 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas.
   1. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly seeded areas from traffic.
   1. Maintain fencing and barricades throughout initial seed establishment.

C. Remove nondegradable erosion-control measures after grass establishment period.

D. During landscape installation:
   1. All areas shall be reasonably clean at the end of each workday.
   2. Sidewalks and other paved areas shall be swept or washed down as needed.

E. Project completion:
   1. All debris, soil, and trash resulting from landscape operations shall be removed from the site.
   2. All paved areas shall be washed down.

END OF SECTION

SECTION 02952

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

1.02 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Limiting dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

1.03 SUBMITTALS

A. Mix designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate base course: As specified in Section 02050 - Soil and for Earthwork.

B. Asphalt pavement: As specified in Section 02742 - Asphaltic Concrete Paving.

C. Portland cement concrete replacement material: Class A concrete as specified in Section 03300 - Cast-in-Place Concrete.

2.02 EQUIPMENT

A. Roads, pavements, parking areas, and walks:
   1. Equipment requirements: Good condition, capable of performing work intended in satisfactory manner.

2.03 ACCESSORIES

A. Material for painting asphalt concrete pavement: Tack coat as specified in Section 02742 - Asphaltic Concrete Paving.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate surface removal replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement removal and temporary asphalt replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to centerline of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt pavement replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of Engineer.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and all costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.
   4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland cement concrete pavement replacement:
   1. Where trenches lie within portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.
   2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.
   3. Provide expansion joints that match existing.
   4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
   5. Surface finish: Wood float finish.

E. Curb, gutter, and sidewalk replacement:
   1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed:
      a. Provide expansion joints of same spacing and thickness as original construction.

F. Asphalt pavements:
   1. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.
   2. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements.
   3. No extra payment will be made for these items and all costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
   1. Asphalt concrete as specified in Section 02742 - Asphaltic Concrete Paving.
   2. Concrete as specified in Section 03300 - Cast-in-Place Concrete.

B. Inspection:
   1. Asphalt concrete:
      a. Lay 10-foot straightedge parallel to centerline of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
      b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.
   2. Portland cement concrete replacement pavement:
      a. Lay 10-foot straightedge either across pavement replacement or longitudinal with centerline of gutter or ditch.
      b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 03055

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

A. American Concrete Institute (ACI).
   1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

C. ASTM international (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

D. Concrete Reinforcing Steel Institute (CRSI).

E. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

G. Society for Protective Coatings (SSPC):
   1. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

A. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

1.04 SUBMITTALS

A. Product data: Technical data for adhesives, including:
   1. Manufacturer's printed installation instructions (MPII).
   2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification

factors for temperature, spacing, edge distance, and other installation variables.
3. Handling and storage instructions.
4. Evidence of current listing under NSF-61 for use in contact with potable water.

B. Quality control submittals:
1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01410 - Regulatory Requirements.
2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
3. Installer qualifications:
a. Submit evidence of successful completion of adhesive manufacturer's installation training program.
b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.

C. Inspection and testing reports:
1. Inspections: Field quality control: Reports of inspections and tests.
a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

A. Qualifications:
1. Installation requirements:
a. Have available at the site, and install anchors in accordance with, the adhesive manufacturer's printed installation instructions.
2. Installer qualifications:
a. Demonstrating successful completion of adhesive manufacturer's on-site training program for installation of adhesive-bonded anchors.
b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the Building Official.
1) Organizations/certification programs deemed to be qualified are:
a) ACI-CRSI Adhesive Anchor Installer Certification Program.
b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the Building Official.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area protected from weather.
2. Control temperature to maintain storage within manufacturer's recommended temperature range.
a. If products have been stored at temperatures outside manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

A. As specified in Section 01612 - Seismic Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

B. Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements or ACI 355.4 and of ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.

C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

D. For locations where adhesive will be in direct contact with potable water in the finished work, provide documentation of testing and listing under NSF-61. Testing shall be by a nationally recognized agency acceptable to the Engineer.

2.02 EPOXY ADHESIVE

A. Materials:
   1. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   2. 2-component, 100 percent solids, insensitive to moisture.
   3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
      a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-RE 500-V3.
   2. Simpson Strong-Tie Co., Inc., SET-XP.

2.03 ACRYLIC AND HYBRID ADHESIVE

A. Materials:
   1. 2-component, high-solids, acrylic-based or hybrid acrylic and epoxy-based adhesive.
   2. Approved by the manufacturer for installation at substrate temperatures of 0 degrees Fahrenheit and above.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-HY-200.
   2. Simpson Strong-Tie Co., Inc., AT-XP.

2.04 ALL THREAD RODS

A. Materials: As specified in Section 05120 - Structural Steel for rods, nuts and washers.

2.05 REINFORCING BARS

A. As specified in Section 03200 - Concrete Reinforcing.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official.
   1. Do not install holes or adhesive until training is complete.

B. Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.

C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
   1. If embedment depth is not indicated, contact Engineer for requirements.
   2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by Engineer.

3.02 PREPARATION

A. Do not begin installation of adhesive bonded anchors until:
   1. Concrete has achieved an age of at least 21 days after placement.
   2. On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.

B. Review manufacturer's printed installation instructions (MPII) and "conditions of use" stipulated in the Evaluation Report before beginning work.
   1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents and resolve before proceeding with installation.

C. Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

D. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by Engineer.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
      a. Installation of anchors in cored holes is not permitted.
      b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.
      c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
   2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a "condition of use" in the Evaluation Report.
      a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.

D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
      a. Obtain Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
      b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
      c. Epoxy grout may be substituted for dry-pack mortar when accepted by Engineer.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
   3. When existing reinforcing steel is encountered during drilling and when specifically accepted by Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
   4. Bent bar reinforcing bars: Where edge distances are critical, and interference with existing reinforcing steel is likely, if acceptable to Engineer, drill hole at 10-degree (or less) angle from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
   1. Insert air nozzle to bottom of hole and blow out loose dust.
      a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
      b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
   2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
      a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
      b. Repeat at least 4 times.
   3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
   4. Leave prepared holes clean and dry.
   5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
   6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
   2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
   1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
   2. Fill hole as nozzle is withdrawn without creating air voids.
   3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
   4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods.
   1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
   2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer's recommended procedures.
   3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
   4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
   5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading.
   1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
   2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
   1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
   2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01450 - Quality Control.

B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
   1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
      a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
   2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
   1. Hole drilling and preparation.
   2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455 - Special Tests and Inspections.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
      b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
      c. Provide continuous inspection of all drilling, cleaning and bonding activities for bars and rods installed in horizontal and upwardly inclined positions.
   3. Preparation:
      a. Review Drawings and Specifications for the Work to be observed.
      b. Review adhesive manufacturer's MPII and recommended installation procedures.
      c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
   4. Inspection: Periodic:
      a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread

rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.

1) Concrete: Class (minimum specified compressive strength) and thickness.
2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "conditions of use" listed in the Evaluation Report.
4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.

b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
   1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
   2) For ongoing installations, the special inspector visits the site at least once for every 4 hours of work during each day of installation to observe the work for compliance with material requirements and installation procedures.

5. Inspection: Continuous.
   a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.
6. Records of inspections:
   a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
   b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Provide epoxy materials that are new.
   2. Store and use products within limitations set forth by manufacturer.
   3. Perform and conduct work of this Section in neat orderly manner.

1.04 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product Data: Submit manufacturer's data completely describing epoxy materials:
   1. Submit evidence of conformance to ASTM C881. Include manufacturer’s designations of Type Grade, Class, and Color.
   2. Submit documentation that materials meet or exceed the specified strength and performance characteristics. Indicate test methods and test results.
   3. Submit documentation confirming listing under NSF-61.

C. Quality control submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Moisture tolerant, water-insensitive, two-component epoxy resin adhesive material containing 100 percent solids, and meeting or exceeding the performance properties specified when tested in accordance with the standards specified.
   2. Listed under NSF-61 for use in direct contact with potable water.

B. Epoxy: Low viscosity product in accordance with ASTM C881; Types I, II and IV; Grade 1; Class C.
   1. Manufacturers: One of the following or equal:
      a. Dayton Superior, Sure Inject J56.
      b. Sika Corporation, Sikadur 35 Hi-Mod LV.
   2. Required properties:

Table 1 - Material Properties - Epoxy.

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D638	7,100 pounds per square inch, minimum.
Compressive Strength (7-day)	ASTM D695	11,000 pounds per square inch, minimum.
Bond Strength (2-day)	ASTM C882	1,500 pounds per square inch, minimum. Concrete failure before failure of epoxy.
Viscosity (mixed)		250-550 centipoise

Notes:

Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.

C. Epoxy gel: Non-sagging product in accordance with ASTM C881, Types I and IV, Grade 3, Class C.
   1. Manufacturers: One of the following or equal:
      a. Sika Corp., Sikadur 31, Hi-Mod Gel.
   2. Required properties:

Table 2 - Material Properties - Epoxy Gel.

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D638	2,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,000 pounds per square inch, minimum.
Bond Strength (14-day)	ASTM C882	1,500 pounds per square inch, minimum.

Table 2 - Material Properties - Epoxy Gel.		
Property	**Test Method**	**Required Results ("neat")**
Notes: Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

D. Epoxy bonding agent: Non-sagging product in accordance with ASTM C881, Type II, Grade 2, Class C.
   1. Manufacturers: One of the following or equal:
      a. Sika Chemical Corp., Sikadur 32 Hi-Mod LPL.
   2. Required properties:

Table 3 - Material Properties - Epoxy Bonding Agent		
Property	**Test Method**	**Required Results**
Tensile Strength (7-day)	ASTM D638	3,300 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,300 pounds per square inch, minimum.
Bond Strength (14-days)	ASTM C882	1,800 pounds per square inch, minimum. Concrete failure before failure of epoxy bonding agent.
Pot Life	-	Minimum 70 minutes at 77 degrees Fahrenheit.
Notes:	Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.	

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Bonding agent will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03102

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):

1. 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.

B. NSF International (NSF):

1. 61 - Drinking Water System Components - Health Effects.

C. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Green concrete: Concrete with less than 100 percent of the minimum specified compressive strength (f'_c).

1.04 SYSTEM DESCRIPTION

A. Design requirements:

1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:

1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
4. Use forms that are clean and free from dirt, concrete, and other debris.
    a. Coat with form release agent if required, prior to use or reuse.

1.05 SUBMITTALS

A. Information on proposed forming system:

1. Submit in such detail as the Engineer may require to assure themselves that intent of the Specifications can be complied with by use of proposed system.

2. Alternate combinations of plywood thickness and stud spacing may be submitted.

B. Form release agent. NSF 61 certification prepared by NSF, Underwriters Laboratories (UL) or other, similar, nationally recognized testing laboratory acceptable to the Engineer.

1.06 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by manufacturers having a minimum of 5 years of experience, except as otherwise specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install work of this Section in accordance with local, state, and federal regulations.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Forms: Built-up plywood:

1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:

a. Size and material:

1) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.

2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

b. Wales: Minimum 2-inch by 4-inch lumber.

c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

B. Forms: Steel or steel framed:

1. Steel forms:

a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.

b. Capable of providing finish surfaces that are flat without bows, cups, or dents.

2. Steel framed plywood forms:

    a. Provide forms that are rigidly constructed and capable of being braced.

    b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

C. Form release agent.

1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.

2. Certified for conformance to NSF 61 and leaving no taste or odor on the concrete surface.

D. Form ties:

1. General:

    a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.

    b. Do not use wire ties or wood spreaders of any form.

    c. Provide ties of type that accurately tie, lock, and spread forms.

    d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.

    e. Do not allow holes in forms for ties to allow leakage during placement of concrete.

2. Cone-snap ties:

    a. Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.

    b. Provide neoprene waterseal washer that is located near the center of the concrete.

3. Taper ties:

    a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

E. Incidentals:

1. External angles:

    a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.

    b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, and construction joints.

2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:

1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms: Built-up plywood:

1. Studding:

a. Spaced at 16 inches or 24 inches on center.

b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.

c. Install studs perpendicular to grain of exterior plys of plywood sheets.

2. Wales: Form wales of double lumber material with minimum size as specified in this Section.

3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

B. Forms: Steel or steel framed:

1. Steel forms:

a. Adequately brace forms for minimum deflection of finish surface.

2. Steel framed plywood forms:

a. Rigidly construct and brace with joints fitting closely and smoothly.

b. Number of form reuses: Depends upon durability of surface coating or overlay used.

3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

C. Form bracing and alignment:

1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.

2. Formwork:

a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.

b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.

3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:

a. Spreading and vertical or horizontal displacement of forms.

b. Grout "bleeding" on finish concrete surfaces.

4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.

5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

D. Forms: Incidentals:

1. Keyways: Construct as indicated on the Drawings.

2. Reentrant angles: May be left square.

3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.

4. Inserts:

a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.

5. Pipe and conduit penetrations:

a. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 07900 - Joint Sealants.

E. Form release agent:

1. Apply in accordance with manufacturer’s instructions.

F. Form ties:

1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally.

3.03 FORM REMOVAL

A. Keep forms in place for at least the periods indicated in the following paragraphs.

1. Vertical forms:

a. Keep vertical forms in place for a minimum of 24 hours after concrete is placed.

b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.

2. Other forms and shoring: Keep in place:

a. Sides of footings: 24 hours minimum.

b. Vertical sides of beams, girders, and similar members: 48 hours minimum.

c. Bottom of slabs, beams, and girders: Until concrete strength reaches specified strength f'_c or until shoring is installed.

d. Shoring for slabs, beams, and girders: Shore until concrete strength reaches specified strength.

e. Wall bracing: Brace walls until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Green concrete:

1. No heavy loading on green concrete will be permitted.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03300 - Cast-in-Place Concrete.

B. Form ties: Remove form ties from surfaces. Fill tie holes as follows:

1. Remove form ties from surfaces.

2. Roughen cone shaped tie holes by heavy sandblasting before repair.

3. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03600 - Grouting.

4. Taper ties:

a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:

1) Heavy sandblast and then clean tie holes.

2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.

3) Locate steel rod in cylindrical recess and against middle of plug during driving.

a) At no time are plugs to be driven on flat area outside cylindrical recess.

b. Dry-pack of taper tie holes:

1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03600 - Grouting.

a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.

b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.

c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:

(1) Cover with minimum of 10 mils of epoxy gel.

(2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.

(3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 TOLERANCES

A. Finished concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct work within the tolerances in accordance with ACI 117, except as modified in the following paragraphs or as indicated on the Drawings.

1. General:

   a. At certain locations in the Work, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements of this Section.

   b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.

2. Slabs:

   a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.

   b. Slabs indicated to be level: Have maximum vertical deviation of 1/8-inch in 10-foot horizontal length without any apparent changes in grade.

3. Circular tank walls:

   a. The Contractor may deviate from finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.

4. Inserts and embedments:

   a. Set inserts and embedments to tolerances required for proper installation and operation of equipment or systems to which insert pertains.

   b. Maximum tolerances: As follows:

Item	Tolerance
Sleeves and inserts	Plus 1/8 Minus 1/8 inches.
Anchor bolts:	
Projected ends	Plus 1/4 Minus 0.0 inches.
Axial alignment	Not more than 2 degrees off the axis indicated on the Drawings.
Setting location	Plus 1/16 Minus 1/16 inches.

C. Remove and replace work that does not conform to required tolerances. Procedures and products employed in and resulting from such re-work shall be acceptable to the Engineer.

END OF SECTION

SECTION 03150

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
   2. D570 - Standard Test Method for Water Absorption of Plastics.
   3. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   4. D638 - Standard Test Method for Tensile Properties of Plastics.
   5. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   6. D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   7. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   8. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   9. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   10. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.

B. American National Standards Institute (ANSI):
   1. A135.4 - Basic Hardboard.

C. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of Engineer.
   2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
   1. Use specific type in applications as indicated on the Drawings.
   2. Do not use scrap or recycled materials to manufacture joint fillers.

B. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width indicated on the Drawings.
         2) Asphalt-impregnated fiber in accordance with ASTM D1751.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Fibre Expansion Joint.
   2. Synthetic sponge rubber expansion joint material:
      a. Properties:
         1) Thickness: As recommended for width indicated on the Drawings.
         2) Material in accordance with ASTM D1752, Type I.
      b. Manufacturers: One of the following or equal:
         1) Williams Products Inc., Everlastic 1300.
         2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corp.
      b. Sika Corp., Greenstreak PVC Waterstop.
   3. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
      e. No scrap or reclaimed material shall be used.
   4. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D638	Not less than 300 percent.
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 degrees Fahrenheit.

Physical Characteristics	Test Method	Required Results
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

2.03 JOINT DOWELS

A. Expansion joint dowels:
   1. Smooth, un-deformed steel bars conforming to ASTM A615, Grade 60.
   2. Provide dowels straight and clean, free of loose flaky rust and loose scale.
   3. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inches on the diameter of the dowel and extends no more than 0.04 from the end.
   4. Expansion end of the dowel:
      a. Coat bars with a bond breaker.
      b. Provide expansion dowel caps.

B. Slip dowel plastic sleeves: Manufactured using polypropylene:
   1. Manufacturers: The following or equal:
      a. Sika Corp., speed dowel.

C. Slip dowel end caps:
   1. Manufacturers: One of the following or equal:
      a. Heckmann Building Products, Inc., No. 87 Dowel Caps.
      b. Dayton Superior Corp., Style K-11 Dowel Caps.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
   1. General:
      a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints where indicated on the Drawings.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
      e. Provide waterstops that are continuous.
      f. Set waterstops accurately to position and line as indicated on the Drawings.
      g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
      h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
      i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
      j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
      k. Special clips may be used in lieu of wires, at Contractor's option.
      l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
      m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
      n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.
   2. Polyvinyl chloride waterstop:
      a. Install waterstops so that joints are watertight.
      b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
         1) Do not damage material by heat sealing.
         2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
         3) Maintain continuity of waterstop ribs and tubular center axis.
         4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.
      c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.

d. Prefabricate waterstop joints involving more than 2 butt ends to be joined together, including all joints that involve an angle cut, alignment change, or joining of 2 dissimilar waterstop sections, prior to placement in form.
    1) Provide not less than 24-inch long strips of waterstop material beyond joint.
    2) After inspection and acceptance, install such prefabricated waterstop joint assemblies in forms and butt-weld ends of 24-inch strips to straight run portions of waterstop in place in forms.
e. Manufacturer shall factory prefabricate joints for crosses and tees.
f. Split-type waterstops will not be permitted except where specifically indicated on the Drawings.

B. Joints:
1. Construct construction and expansion joints as indicated on the Drawings.
2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

C. Expanded polystyrene joint filler:
1. When filler is indicated on the Drawings or specified, place filler in correct position before concrete is placed against filler.
2. Fill holes and joints in filler with caulking to prevent entry of mortar into joint or passage of mortar or concrete from one side of joint to other.

END OF SECTION

SECTION 03155

THERMOPLASTIC ELASTOMERIC RUBBER WATERSTOPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstop embedded in concrete and spanning contraction (control), expansion, or construction joints to create a continuous diaphragm to prevent fluid migration.
   2. Nonmetallic waterstops for use in concrete joints subjected to ozone or ozonated water.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   2. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   3. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   4. D1171 - Standard Test Method for Rubber Deterioration- Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
   5. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.

1.03 SUBMITTALS

A. Product data.

1.04 QUALITY ASSURANCE

A. Waterstop splicing defects which are unacceptable include, but are not limited to:
   1. Tensile strength less than 60 percent of parent section.
   2. Adhesives, solvents, and free lap joints.
   3. Misalignment of center bulb and end bulbs greater than 1/16 inch.
   4. Misalignment which reduces waterstop cross section area more than 15 percent.
   5. Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness.
   6. Combination misalignment and bond failure with net reduction of waterstop cross-section area greater than 15 percent.
   7. Misalignment of splice resulting in waterstop misalignment in excess of 1/2-inch in 10 feet.
   8. Visible porosity in the welded joint, including pinholes.
   9. Charred or burnt material.
   10. Bubbles or inadequate bonding detectable with a penknife.
   11. Visible signs of splice separation when cooled splices are bent by hand at a sharp angle.
   12. Edge welding.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store waterstop under tarps to protect from dirt, debris, or damage.

PART 2 PRODUCTS

2.01 CHEMICAL RESISTANT WATERSTOP MATERIAL

A. Manufacturer: The following or equal:
   1. Sika Corp., Westec Envirostop TPER Waterstop.

B. Thermoplastic elastomeric rubber (TPER): Synthetic rubber with high resistance to wide range of oils, solvents and chemicals and not readily soluble in common solvents.

Property	Test Method	1993 WTC Average Values	Recommended Limit
Tensile Strength	ASTM D412	1,800 psi (12.41 MPa)	1,750 psi (12.07 MPa) min
Ultimate Elongation	ASTM D412	450%	400% min
100% Modulus	ASTM D412	1,000 psi (6.89 MPa)	
Tear Strength	ASTM D624	278 lb/in at 77EF	
Brittle Point	ASTM D746	-70EF/-57EC	-58EF/-50EC
Ozone Resistance	ASTM D1171	Passed 450 ppm	
Shore Hardness	ASTM D2240	87 Units	85 ∀5

2.02 NONMETALLIC WATERSTOP SHOP SPLICE FABRICATIONS

A. Provide factory-fabricated waterstop corners and transitions leaving only straight butt joint splices for the field.

B. Use Teflon™-covered, thermostatically controlled waterstop splicing iron at approximately 380 degrees Fahrenheit to 410 degrees Fahrenheit for TPER.

C. Splices to be dense, homogeneous, and nonporous with tensile strength not less than 60 percent of the parent section and shall permanently retain their flexibility.

D. Waterstop intersections and directional changes to be miter cut and heat welded with center bulb aligned to maintain continuity.

E. Adhesives, solvents, and lap joints are not acceptable.

F. Edge welding is not acceptable.

G. Welds to exhibit continuous bead of excess melted material.

H. Allow material to cool before bending or distorting the fabrication.

I. Splices to be free from defects as defined under "Quality Assurance."

PART 3 EXECUTION

3.01 EXAMINATION

A. Notify Engineer 24 hours prior to placement of concrete at waterstops.

B. Inspect waterstop and field splices for defects immediately prior to placing concrete.

C. Replace damaged waterstop and unacceptable defective waterstop splice fabrications.
   1. Remove from site and dispose of defective material.

3.02 PREPARATION

A. Ensure steel reinforcing bars do not interfere with proper position of waterstop.

B. Protect waterstops during progress of work.

C. Uncoil waterstop 24 hours prior to installation to ease handling, installation, and fabrication.

D. Clean joints of dirt and construction debris.

3.03 NONMETALLIC WATERSTOP FIELD SPLICE FABRICATION

A. Weld straight butt joint splices per requirements for shop fabricated fittings.

B. Cut waterstop ends with miter box guide and circular saw to ensure good, full contact at joints.

3.04 INSTALLATION

A. Position waterstop in joint as indicated on the Drawings.

B. Center waterstop on joint, with approximately one-half of waterstop width to be embedded in concrete on each side of joint.

C. Allow clearance between waterstop and reinforcing steel of a minimum 2 times the largest aggregate size.
   1. Prevent rock pockets and air voids caused by aggregate bridging.

D. At expansion joints, keep center bulb un-embedded.

E. Secure waterstop in correct position using hog rings crimped between end bulbs on 12-inch maximum centers and wire tie to adjacent reinforcing steel.
   1. Center-to-center spacing may be increased upon written request and approval. Use split formwork bulkhead.

F. Carefully place concrete without displacing waterstop from proper position.

G. Thoroughly and systematically vibrate concrete around waterstop to obtain impervious, void-free concrete in the vicinity of the joint, and to maximize intimate contact between concrete and waterstop.

H. After first pour, clean un-embedded waterstop leg to ensure full contact of second pour concrete.
   1. Remove laitance, spillage, form oil, and dirt.

END OF SECTION

SECTION 03200

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Reinforcing bars.
      a. Carbon steel.
   2. Thread bars.
   3. Bar supports.
   4. Tie wires.
   5. Welded wire fabric.
   6. Mechanical reinforcing bar couplers.
   7. Mechanical reinforcing bar end anchors (terminators).

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.
   2. SP-66 - ACI Detailing Manual.

B. American Iron and Steel Institute (AISI).

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

D. ASTM International (ASTM):
   1. A493 - Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   2. A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   3. A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   4. A1064 - Standard Specification of Carbon-Steel wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

E. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.

F. ICC Evaluation Service (ICC-ES):
   1. AC133 - Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcing Bars.
   2. AC347 - Acceptance Criteria for Headed Deformed Bars.

1.03 DEFINITIONS

A. Architectural concrete: Concrete surfaces that will be exposed to view in the finished work.

1. Additionally, for purposes of this Section,includes:
    a. Concrete surfaces that are designated to receive paints or coatings.
    b. Exposed concrete in open basins, channels, and similar liquid containing structures:Surfaces shall be considered exposed to view if located above a line 2 feet below the normal operating water surface elevation in that structure.

B. Bars: Reinforcement or reinforcing bars as specified in this Section.

C. Evaluation Report: Report prepared by ICC-ES , or by other testing agency acceptable to the Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

D. Give away bars: Reinforcing bars that are not required by the Contract Documents, but are installed by the Contractor to provide support for the required reinforcing bars.

E. Wire supports: Metal reinforcing supports constructed of steel wire as specified. Includes individual high chairs, continuous high chairs, bolsters and other similar configurations and shapes.

1.04 SYSTEM DESCRIPTION

A. The drawings contain notes describing the size and spacing of reinforcement and its placement, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete, and other related information.

1.05 SUBMITTALS

A. General:
    1. Submit in accordance with Section 01330 - Submittal Procedures.
    2. Changes to reinforcement in Contract Documents:
        a. Indicate in a separate letter submitted with shop drawings any changes to reinforcement indicated on the Drawings or specified.
        b. Such changes will not be acceptable unless Engineer has accepted them in writing.

B. Product data:
    1. Bar supports:
        a. Wire bar supports:
            1) Schedule of support materials to be provided and locations of use.
        b. Precast concrete bar supports ("dobies"):
            1) Manufacturer's data indicating compression strength of concrete and confirming dimensions and thickness(es).height(s) to be provided for each location where used.
    2. Mechanical reinforcing bar couplers. For each type and/or series to be provided:
        a. Evaluation Report documenting compliance with the requirements of ICC-ES AC133.

b. Details, properties, and dimensions of couplers. Include type or size identification, and bar size(s) and grade(s) for which the coupler is suitable.
c. Manufacturer’s installation and testing instructions.
d. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

3. Mechanical reinforcing bar end anchors (terminators).
a. Evaluation Report documenting compliance with the requirements of ICC-ES AC307.
b. Details, properties, and dimensions of end anchors. Include type or size identification, and bar size(s) and grade(s) for which the end anchor is suitable.
c. Manufacturer’s installation and testing instructions.
d. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

C. Shop drawings:
1. Reinforcement shop drawings:
a. Submit drawings showing bending and placement of reinforcement required by the Contract Documents.
b. Clearly indicate structures or portions of structures covered by each submittal.
1) Submit reinforcement shop drawings for each structure as a complete package. Submittals addressing only a portion of a structure will be rejected and returned without review, unless such presentation is accepted by Engineer in advance.
c. Shop drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and ACI SP-66.
d. Use the same bar identification marks on bending detail drawings, placement drawings, and shipping tags.
e. Submittals consisting solely of reinforcing bar schedules, without accompanying placement drawings, will not be accepted unless accepted under prior written agreement with Engineer.
2. Reinforcement placement drawings:
a. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
b. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
c. Show splice locations.
d. Indicate locations of mechanical reinforcing couplers if used.
e. Show locations of reinforcing bar end anchors, if used.
3. Reinforcement fabrication drawings:
a. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations.
Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

D. Samples (when requested by Engineer):
   1. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.
   2. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

E. Test reports:
   1. Certified copy of mill test for each steel used. Show physical properties and chemical analysis.
      a. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.
      b. In such cases, submit certificates under the shop drawing submittal number with the letter "R" (for record date) appended to the end (e.g., of the reinforcement was submitted as 03200-002-1, deliver the associated mill certificate as submittal 03200-002-1R).
   2. Mechanical reinforcing bar couplers:
      a. Current Evaluation Report confirming that couplers provide specified tension and compression strength and conform to specified limits on total slip within the coupler.
      b. Certified copy of mill tests for heat(s) of steel incorporated into the reinforcing bar couplers shipped.
      c. For threaded sleeve type couplers, heat treatment lot numbers for each shipment.
   3. Reinforcing bar end anchors:
      a. Current Evaluation Report confirming that end anchors provide specified tension strength.
      b. Certified copy of mill tests for heat(s) of steel incorporated into the materials shipped.

F. Manufacturer's instructions:
   1. Mechanical reinforcing bar couplers:
      a. Manufacturer's installation instructions.
      b. Manufacturer's instructions for confirmation testing of couplers after reinforcing bars have been inserted into the couplers.
   2. Mechanical reinforcing bar end anchors:
      a. Manufacturer's installation instructions.
      b. Manufacturer's instructions for confirmation testing of end anchors.

G. Special procedures:
   1. Welding procedures conforming to AWS D1.4 for reinforcement to be field welded.
      a. Procedures qualification record.

H. Qualifications statements:
   1. Welder qualifications.

I. Closeout documents:
   1. Field quality control and inspection reports.
   2. Field quality assurance special inspection and testing reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:
   1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks with letter containing manufacturer's guarantee of grade.

1.07 SEQUENCING AND SCHEDULING

A. Bar supports:
   1. Do not place concrete until samples and product data for bar supports have been accepted by Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.
   2. Reinforcing bars:
      a. ASTM A615 Grade 60 deformed bars, including the following requirements, or ASTM A706 Grade 60 deformed bars.
         1) Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
         2) Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
   3. Reinforcing bars designated or required to be welded:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.
      b. ASTM A615 Grade 60 deformed bars may be used in lieu of ASTM A706 Grade 60 if following requirements are satisfied.
         1) Welding procedures conforming to AWS D1.4 are submitted to Engineer.
         2) The specific location for proposed substitution is acceptable to Engineer.

B. Bar supports:
   1. Wire supports:
      a. All stainless steel bar supports:
         1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire conforming to ASTM A493, AISI Type 316.
      b. Stainless steel protected bar supports:
         1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from cold--drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.

2) Stainless steel wire ends shall conform to ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.

c. Bright basic wire bar supports.

1) Conforming to CRSI Manual if Standard Practice, Class 3.

2. Plastic supports:

a. Manufacturers: The following or equal:

1) Aztec Concrete Accessories.

3. Deformed steel reinforcing bar supports:

a. Fabricated of materials and to CRSI details recommended for typical reinforcement embedded in concrete and bent to dimensions required to provide specified clearances and concrete cover.

4. Precast concrete bar supports ("dobies"):

a. Pre-manufactured, precast concrete blocks with cast-in annealed steel wires, 16-gauge or heavier.

b. Compression strength of concrete: Equal to or exceeding the compression strength of the surrounding concrete.

c. Block dimensions:

1) Height to provide specified concrete cover.

2) Footprint not less than 3 inches by 3 inches, and adequate to support the weight of the reinforcement and maintain specified concrete cover without settling into the underlying surface.

C. Tie wires:

1. General use: Black annealed steel wire, 16-gauge or heavier.

D. Welded wire fabric reinforcement:

1. Material:

a. Carbon steel conforming to ASTM A1064.

2. Provide welded wire reinforcement in flat sheet form. Rolled wire fabric is not permitted.

3. Fabric may be used in place of reinforcing bars if accepted by Engineer:

a. Provide welded wire fabric having cross-sectional area per linear foot not less than the cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

E. Mechanical reinforcing bar couplers and end anchors:

1. General:

a. Only products conforming to the requirements of ACI 318 for mechanical splices, and holding a current Evaluation Report that documents the following performance characteristics, will be considered for use.

b. Strength of coupler: Capable of developing tension and compression strength not lower than the lesser of the following:

1) ACI 318 "Type 2" units: In static tension and compression:

a) Minimum 125 percent of the ASTM-specified minimum yield strength of the reinforcement being spliced or terminated.

b) Minimum 100 percent of the ASTM-specified minimum ultimate strength of the reinforcement being spliced or terminated.

c. Slip of reinforcing bars within coupler: Total slip of the reinforcing bars within the splice sleeve limited as follows:

1) For bar sizes #14 and smaller, elongation between gauge points measured clear of the splice sleeve not exceeding 0.010 inches after

coupler has been loaded to a tension of 30,000 pounds per square inch and load relaxed to a tension of 3,000 pounds per square inch.

d. Fabrication:
    1) Threaded joints:
        a) Provide threaded ends designed so that cross-threading of bars will not occur during assembly.
        b) Fabricate male ends for female couplers using coupler manufacturer's bar threading equipment to ensure proper taper and thread engagement.
    2) Mark each sleeve with heat treatment lot number.

2. Couplers: Threaded - Reinforcing bar splice at construction joints.
    a. Steel sleeve butt splice with tapered internal threads in forged or swaged head, and nailing flange for attaching to forms. Provide with matching, tapered male-threaded dowels for insertion and tightening into threaded sleeve after form removal.
        1) Provide sleeve with factory-installed plugs to prevent concrete mortar from entering internally threaded coupler.
        2) Provide optional clipped nailing flanges as required to maintain minimum specified concrete cover over all surfaces of coupler.
    b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC133.
    c. Manufacturers: One of the following or equal:
        1) Dayton Superior, DBDI Splice System.
        2) ERICO-Pentair, Lenton Form Saver.
3. Couplers: Threaded - reinforcing bar splice:
    a. Steel sleeve butt splice with tapered internal threads at each end for joining to matching tapered male threads on reinforcing bars.
    b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC133.
    c. Manufacturers: One of the following, or equal:
        1) Dayton Superior: Taper-Lock System.
        2) ERICO-Pentair: Lenton Taper Threaded Splicing System.
4. Couplers: Threaded - All thread rod to reinforcing bar:
    a. Steel sleeve butt splice with tapered internal threads on one end for joining to matching tapered male threads on reinforcing bars, and straight internal threads at opposite end for joining to matching straight male threads on all-thread rods.
    b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC133.
    c. Manufacturers: The following or equal:
        1) ERICO-Pentair, Lenton Bolt Coupler - S4 or S5 Series.
5. End anchors:
    a. Headed steel disc with tapered internal female threads for joining to matching tapered male threads on reinforcing bars.
    b. Holding current Evaluation Report demonstrating acceptance under ICC-ES AC347.
    c. Manufacturers: One of the following or equal:
        1) Dayton Superior, D350/351 Taper-Lock End Anchor Disc.
        2) ERICO-Pentair, Inc., Lenton Terminator.

2.02 FABRICATION

A. Shop fabrication and assembly:
   1. Cut and bend bars in accordance with provisions of ACI 318 and the CRSI Manual of Standard Practice.
   2. Bend bars cold. Use bending collars to develop the recommended bend radius.
   3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.
   4. Circumferential and radiused reinforcement: Roll to the radius required for its location in the structure before installation.
   5. Bars to be fitted with mechanical couplers or mechanical end anchors:
      a. Fabricate threaded ends for connections in shop using manufacturer's recommended tools. Field fabrication is not allowed.
      b. Cut ends square.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Reinforcing bars and welded wire reinforcement:
      a. Verify that reinforcement is new stock, free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings that will adversely affect bonding capacity when placed in the Work.
   2. Welded wire fabric:
      a. Verify that sheets are not curled or kinked before or after installation.

3.02 PREPARATION

A. Surface preparation:
   1. Reinforcing bars - uncoated:
      a. Clean reinforcement of concrete, dirt, oil and other coatings that will adversely affect bond before embedding bars in subsequent concrete placements.
      b. Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean bars having rust scale, loose mill scale, or thick rust coat.
      c. Partially embedded reinforcement: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placements.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Field-cutting of reinforcing bars is not permitted.
   2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements indicated on the Drawings and specified. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.

Table 1 - Reinforcement Placing Tolerances

Member	Tolerance on Reinforcement Location (1)	Tolerance on Minimum Concrete Cover (1,2)
Slabs, beams, walls and columns except as noted below:		
10 inches thick and less	± 3/8 inch	- 3/8 inch
More than 10 inches thick	± 1/2 inch	- 1/2 inch
Formed soffits:	As noted above	- 1/4 inch
Longitudinal location of bends and ends of reinforcement:		
Conditions not listed below:	± 2 inches	- 1/2 inch
At discontinuous ends of brackets and corbels	± 1/2 inch	- 1/4 inch
At discontinuous ends of other members:	± 1 inch	- 1/2 inch

Notes:
(1) ± indicates "plus or minus;" - indicates "minus;" + indicates "plus."
(2) Tolerance on cover is limited as noted, but decrease in cover shall not exceed one third of the minimum cover indicated on the Drawings.

   3. Spacing between bars:
      a. Minimum clear spacing between bars in a layer:
         1) As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      b. Minimum clear spacing between bars in 2 or more parallel layers:
         1) Place bars in upper layers directly above bars in lower layers.
         2) Minimum spacing between layers: As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.
   4. Lap splices for bars:
      a. Lap splice locations and lap splice lengths: as indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.
      b. Unless otherwise specifically indicated on the Drawings (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.
      c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.
      d. Stagger lap splices where indicated on the Drawings.
      e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
   1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces.
      a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
   2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.
   3. Do not use "give away bars" that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for give away bars.
   4. Provide bar supports of height required to maintain the clear concrete cover indicated on the Drawings.
   5. Provide bar supports at formed vertical faces to maintain the clear concrete cover indicated on the Drawings.
   6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

Table 2 - Reinforcement Support Materials

Case	Location	Material
a.	Concrete placed over earth and concrete seal slabs ("mud mats"):	Precast concrete bar supports.
b.	Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings):	All stainless steel bar supports.
c.	Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work	All stainless steel bar supports.
d.	Concrete placed against forms and exposed to interior equipment/piping areas in the finished work	All stainless steel bar supports.
e.	Between mats of reinforcement, and fully embedded within a concrete member	Bright basic wire bars supports, or deformed steel reinforcing bars.

D. Tying of reinforcing:
   1. Fasten reinforcement securely in place with wire ties.
   2. Tie reinforcement at spacings sufficient to prevent shifting.
      a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   3. Tie slab bars at every intersection around perimeter of slab.

4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

Table 3 - Maximum Spacing of Tie Wires for Reinforcement		
Bar Size	**Slab Bar Spacing (inches)**	**Wall Bar Spacing (inches)**
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

5. After tying:
   a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.
   b. Remove tie wire clippings from inside forms before placing concrete.

E. Welded wire fabric reinforcement:
1. Install only where indicated on the Drawings or accepted in advance by Engineer.
2. Install necessary tie wires, spacing chairs, and supports to keep welded wire fabric at its designated position in the concrete section while concrete is being placed.
3. Straighten welded wire fabric to make sheets flat in the Work.
4. Do not allow wire fabric to drape between supports unless such a configuration is specifically indicated on the Drawings.
   a. If fabric is displaced during placement of concrete, make provisions to restore it to the designated location using methods acceptable to Engineer.
5. Bend welded wire fabric as indicated on the Drawings or required to fit Work.
6. Lap splice welded wire fabric as indicated on the Drawings.
   a. If lap splice length is not indicated, splice in accordance with ACI 318, but not less than 1 1/2 courses of fabric or 8 inches minimum. Tie laps at ends and at not more than 12 inches on center.

F. Welding reinforcing bars:
1. Weld reinforcing bars only where indicated on the Drawings or where acceptance is received from Engineer prior to welding.
2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by Engineer.
   a. Conform to requirements for minimum preheat and interpass temperatures.
3. Submit:
   a. Welding procedures specification.
   b. Procedures qualification record.
   c. Welder qualification test record.
4. Do not tack weld reinforcing bars except where specifically indicated on the Drawings.

G. Reinforcing bar mechanical couplers and end anchors:
   1. Install only at locations indicated on the Drawings or where prior approval has been obtained from Engineer.
   2. Install in accordance with manufacturer's instructions and requirements of Evaluation Report.
      a. Make splices using manufacturer's standard equipment, jigs, clamps, and other required accessories.
      b. After assembly of the splice, tighten using torque load not less than that recommended by the manufacturer.
   3. Unless greater cover is indicated on the Drawings, provide clear cover from surface of concrete to outside face of couplers that is not less than the minimum concrete cover specified for typical reinforcement.
      a. If cover is less than required, contact Engineer for evaluation of conditions before modifying locations of bars or placing concrete.
      b. Modifications to maintain or provide required concrete cover, such as addition of concrete ; re-positioning of stirrups, ties, etc., may be completed only after approval by Engineer.

3.04 FIELD QUALITY CONTROL

A. Provide quality control for the Work of this Section as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
   1. Submit records of inspections and testing to Engineer in electronic format within 24 hours after completion.

C. Manufacturer's services:
   1. Furnish manufacturer's technical representative to conduct jobsite training regarding proper storage, handling, and installation of mechanical reinforcing bar couplers and bar end anchors for personnel who will perform the installation. Engineer may attend training session.

3.05 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections and tests:
   1. Provide as specified in Section 01455 - Special Tests and Inspections.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Building Code specified in Section 01410 - Regulatory Requirements.
   3. Preparation:
      a. Review Drawings and Specification for the Work to be observed.
      b. Review approved submittal sand shop drawings.
   4. Inspections: Special inspection shall include, but is not limited to, the following items.
      a. Reinforcement: General:
         1) Type (material) and location of reinforcement supports.
         2) Bar material/steel grade and bar size.
         3) Location, placement, and spacing of bars.
         4) Clear concrete cover over reinforcement.

5) Lap splice: Location and lap length. Bars within tolerances for contact (unless non-contact splice is indicated on the Drawings).
6) Bar hooks and development lengths embedded within concrete sections as indicated on the Drawings.
7) Reinforcement tired in position and tie wire legs turned inward toward the center of the concrete section.

b. Reinforcement: Welding:
1) Inspector qualification and inspections shall be in accordance with the requirements of AWS D1.4.
2) Provide periodic inspection for:
a) Weldability of reinforcement other than ASTM A706.
b) Single pass fillet welds with thickness less than or equal to 5/16 inch.
3) Provide continuous inspection for:
a) Other welds.
b) Welds at mechanical reinforcing bar couplers and end anchors.
4) In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods, including radiographic inspection.

5. Mechanical reinforcing bar couplers and end anchors:
a. Special inspection shall include, but is not limited to, the following items:
1) Coupler and end anchor model and identification.
2) Couplers and end anchors are installed in accordance with the requirements of the Engineering Report for each product.
3) Confirmation of the following:
a) Grade and size of reinforcing bars.
b) Position of couplers and end anchors.
c) Insertion length of reinforcement.
d) Tightening of bars in the couplers and end anchors.

6. Records of inspections:
a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspections.

3.06 NON-CONFORMING WORK

A. Before placing concrete, adjust or remove and re-install reinforcement to conform to the requirements of the Contract Documents.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 305 - Hot Weather Concreting Standard.
   2. 306 - Cold Weather Concreting Standard.
   3. 318 - Building Code Requirements for Structural Concrete and Commentary.
   4. 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   5. Manual of Concrete Practice.

B. ASTM International (ASTM):
   1. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C94 - Standard Specification for Ready-Mixed Concrete.
   8. C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
   9. C117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
   10. C123 - Standard Test Method for Lightweight Particles in Aggregate.
   11. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   12. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   13. C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.
   14. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
   15. C150 - Standard Specification for Portland Cement.
   16. C156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
   17. C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   18. C171 - Standard Specifications for Sheet Materials for Curing Concrete.
   19. C172 - Standard Practice for Sampling Freshly Mixed Concrete.

20. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
21. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
22. C295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
23. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
25. C494 - Standard Specification for Chemical Admixtures for Concrete.
26. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
27. C856 - Standard Practice for Petrographic Examination of Hardened Concrete.
28. C1260 - Standard Test Method of Potential Alkali Reactivity of Aggregates (Mortar Bar Method).
29. C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
30. D75 - Standard Practice for Sampling Aggregates.
31. D2103 - Standard Specification for Polyethylene Film and Sheeting.

C. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Cementitious materials: Portland cement and fly ash.

C. Cold weather: A period when for more than 3 consecutive days, the average daily outdoor temperature drops below 40 degrees Fahrenheit. The average daily temperature is the average of the highest and lowest temperatures during the period from midnight to midnight. When temperatures above 50 degrees Fahrenheit occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.

D. Cold weather concreting: Operations for placing, finishing, curing, and protection of concrete during cold weather.

E. Green concrete: Concrete with less than 100 percent of the specified strength.

F. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch.

G. Hot weather: A period when project conditions such as low humidity, high temperature, solar radiation, and high winds, promote rapid drying of freshly placed concrete.

H. Hot weather concreting: Operations for placing, finishing, curing, and protection of concrete during hot weather.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, admixtures and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner that will secure lowest water-cementitious materials ratio that is consistent with good workability, plastic and cohesive mixture, and a mixture that is within specified slump range.
      c. Proportion fine and coarse aggregates in manner such as not to produce harshness in placing or honeycombing.
   2. It is the intent of this Section to secure for every part of the Work concrete with homogeneous mixture, which when hardened will have required strength, watertightness, and durability:
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
      b. Construction and expansion joints have been specified and positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of cracks, due to normal expansion and contraction expected from specified concrete mixes.
      c. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
      d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931 - Epoxy Injection System:
         1) Floors and walls of water bearing structures.
         2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
         3) Other items not specified to receive separate waterproof membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
      e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
      f. Pressure injection and sealing: Continue as specified above until structure is watertight and remains watertight for not less than 1 year after final acceptance or date of final repair, whichever occurs later in time.
   3. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, ACI 350, Manual of Concrete Practices, and recommended practices.

1.05 SUBMITTALS

A. Cement mill tests:
   1. Include alkali content representative of each shipment of cement for verification of compliance with specified requirements.

2. Provide mill test reports dated not more than 90 days before the date of submittal.

B. Cold weather concreting:
   1. Procedures for the production, transportation, placement, protection, curing, and temperature monitoring for concrete during cold weather.
   2. Procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

C. Concrete mixes: Full details, including mix design calculations for concrete mixes proposed for use for each class of concrete:
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Source quality test records with mix design submittal:
      a. Include calculations for required compressive strength (f'_{cr}) based on source quality test records.

D. Concrete aggregate tests: Certified copies in triplicate of commercial laboratory tests not more than 90 days old of all samples of concrete aggregates:
   1. Coarse aggregate:
      a. Abrasion loss.
      b. Clay lumps and friable particles.
      c. Coal and lignite.
      d. Materials finer than 200 sieve.
      e. Reactivity.
      f. Shale and chert.
      g. Soundness.
   2. Fine aggregate:
      a. Clay lumps.
      b. Color.
      c. Decantation.
      d. Reactivity.
      e. Shale and chert.
      f. Soundness.

E. Drying shrinkage test data.

F. Fine or coarse aggregate batched from more than 1 bin: Analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

G. Fly ash Certificate of Compliance: Identify source of fly ash and certify compliance in accordance with ASTM C618.

H. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Corrective measures for use prior to placing concrete.

I. Hot weather concreting: Procedures for production, placement, finishing, curing, protection, and temperature monitoring for concrete during hot weather and appropriate corrective measures.

J. Heating equipment for cold weather concreting: Information on type of equipment used for heating materials and new concrete in process of curing during excessively cold weather.

K. Information on mixing equipment.

L. Product data: Submit data completely describing products.

M. Sequence of concrete placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

N. Sieve analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate at least every 3 weeks and at any time there is significant change in grading of materials.

O. Trial batch test data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

P. Weather monitoring: Records of:
   1. Relative humidity.
   2. Site ambient temperature.
   3. Wind speed.

Q. Temperature of freshly placed concrete.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in manner that prevents damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Monitoring weather conditions:
      a. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
      b. Measure and record temperature of fresh concrete. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature of concrete.
      c. Monitor and keep records of the weather forecast starting at least 48 hours prior to placing concrete in order to allow enough time for taking appropriate measures pertaining to Hot or Cold weather concreting.

2. Hot weather concreting:
    a. Initiate evaporation control measures when concrete and air temperatures, relative humidity of the air, and the wind velocity have the capacity to evaporate water from a free surface at a rate that is equal to or greater than 0.2 pounds per square feet per hour. Determine evaporation rate using the Menzel Formula and monograph in ACI 305 3.1.3.
    b. When ambient air temperature is above 85 degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel by water cooling to below 90 degrees Fahrenheit.
    c. Monitor weather conditions at the site including air temperature, humidity, and wind speed, to assess the need for evaporation control measures begin monitoring site conditions no later than 1 hour before the start of concrete placement. Continue to monitor site conditions at intervals of 30 minutes until concrete curing has begun.
    d. Temperature of concrete mix at time of placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
    e. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete:
    f. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.
3. Cold weather concreting:
    a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit:
        1) Make provision for heating water.
    b. Follow recommendations of ACI 306 for preparation, placement, and protection of concrete during cold weather.
    c. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
    d. Heating water, cement, or aggregate materials:
        1) Do not heat in excess of 160 degrees Fahrenheit.
    e. Protection of concrete in forms:
        1) Do not remove forms from concrete when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained its minimum specified compressive strength. Evidence of strength shall be based on by testing of cylinders stored in the field under equivalent conditions to those at the concrete structure.
        2) Protect by means of covering with tarpaulins, or other acceptable covering acceptable to Engineer.
        3) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Admixtures:
   1. General:
      a. Do not use admixtures of any type, except as specified, unless written acceptance has been obtained from the Engineer.
      b. Admixtures shall be compatible with concrete and other admixtures. Admixtures other than pozzolans shall be the products of a single manufacture to ensure compatibility.
      c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight of cement.
      d. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
   2. Air entraining admixture:
      a. Provide concrete with 5 percent, within 1 percent, entrained air of evenly dispersed air bubbles at time of placement.
      b. In accordance with ASTM C260.
   3. Water reducing admixture:
      a. May be used at the Contractor's option.
      b. In accordance with ASTM C494, Type A or Type D.
      c. Not contain air-entraining agents.
      d. Liquid form before adding to the concrete mix.
      e. No decrease in cement is permitted as result of use of water reducing admixture.
   4. Super-plasticizers: Are not to be used without acceptance by Engineer.

B. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
      b. Grade aggregate in accordance with ASTM C136 and D75.
      c. Provide unit weight of fine and coarse aggregate that produces in place concrete with weight of not less than 140 pounds per cubic foot.
      d. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
   2. Fine aggregate:
      a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
      b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances.
         1) In no case shall total exceed percent listed.

Item	**Test Method**	**Percent**
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
Shale or Chert	ASTM C123 ASTM C295*	1 1
Clay Lumps	ASTM C142	1

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C123 are less than 1 percent, Test Method C295 is not required.		

c. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C33.
d. In accordance with NSF 61.

3. Coarse aggregate:
   a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
   b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
   c. In accordance with NSF 61.
   d. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C123 ASTM C295*	1.25 1
Coal and lignite	ASTM C123	1/4
Clay lumps and friable particles	ASTM C142	1/4
Materials finer than Number 200 sieve	ASTM C117	1/2**
* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C295 is not required. ** Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

e. Grading:
   1) Aggregate for Class A, B, C, and D concrete: In accordance with ASTM C33, Size Number 57, except as otherwise specified or authorized in writing by the Engineer.
   2) Aggregate for Class CE concrete for encasement of electrical conduits:
      a) Graded in accordance with ASTM C33, Size Number 8.

C. Concrete sealer:
   1. Manufacturers: One of the following or equal:
      a. Euclid Chemical Co., Diamond Hard.
      b. L&M Construction Chemicals, SealHard.

D. Conduit encasement coloring agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
   2. Manufacturers: One of the following or equal:
      a. Davis Co., #160 Brick Red.
      b. Euclid Chemical Co., Increte Division, “Colorcrete Brick Red.”
   3. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

E. Evaporation retardant:
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterKure ER 50.
      b. Euclid Chemical Co., Eucobar.

F. Keyway material: Steel, plastic, or lumber.

G. Nonslip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Abrasive Materials, Inc.
      b. Euclid Chemical Co., Flexolith Summer Grade.

H. Portland cement:
   1. Conform to specifications and tests in accordance with ASTM C150, Types II or III, low alkali, except as specified otherwise.
   2. Have total alkali containing not more than 0.60 percent.
   3. Exposed concrete in any individual structure: Use only one brand of portland cement.
   4. Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished or repaired.
   5. In accordance with NSF 61.

I. Sheet membrane for curing:
   1. Polyethylene film:
      a. In accordance with ASTM C171.
      b. Color: White.
      c. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
      d. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.

J. Sprayed membrane curing compound: Clear type with fugitive dye in accordance with ASTM C309, Type 1D.

K. Surface sealant system:
   1. In accordance with NSF-61.
   2. Manufacturers: One of the following or equal:
      a. Euclid Chemical Co., Vandex Super.
      b. Kryton International, Inc., Krystol T1.

c. Xypex Chemical Corp., Xypex Concentrate.

L. Water:
1. Water for concrete, washing aggregate, and curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
2. Chlorides and sulfate ions:
a. Water for conventional reinforced concrete: Use water containing not more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.
b. Water for prestressed or post-tensioned concrete: Use water containing not more than 650 milligrams per liter of chlorides calculated as chloride ion, or more than 800 milligrams per liter of sulfates calculated as sulfate ion.

2.02 EQUIPMENT

A. Mixing concrete:
1. Mixers may be of stationary plant, paver, or truck mixer type.
2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
3. Mixing equipment:
a. Capable of combining aggregates, cementitious materials, and water within specified time into thoroughly mixed and uniform mass and discharging mixture without segregation.
b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
c. Proportion cementitious materials and aggregate by weight.

B. Machine mixing:
1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
2. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
3. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
4. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
5. Retempering of concrete will not be permitted.
6. Discharge entire batch before recharging.
7. Volume of mixed material per batch: Not exceed manufacturer's rated capacity of mixer.
8. Mixers:
a. Perform mixing in batch mixers of acceptable type.
b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.

c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
    1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C94.
2. Total elapsed time between addition of water at batch plant and discharging completed mix:
    a. Not to exceed 90 minutes.
    b. Elapsed time at project site shall not exceed 30 minutes.
3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
4. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing cementitious materials:
    a. Weigh cementitious materials separately.
    b. Cement in unbroken standard packages (sacks): Need not be weighed.
    c. Weigh bulk cementitious materials and fractional packages.
6. Measure mixing water by volume or by weight.

B. Concrete proportions and consistency:
   1. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
   2. Prevent unnecessary or haphazard changes in consistency of concrete.
   3. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete Classes, with exception of Class CE.
   4. Aggregate:
      a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
   5. Maximum concrete mix water to cementitious materials ratio, minimum cementitious materials content, and slump range: Conform to values specified in Table A in this Section.
   6. Concrete batch weights: Control and adjust to secure maximum yield. At all times, maintain proportions of concrete mix within specified limits.
   7. Mix modification: If required, by the Engineer, modify mixture within limits set forth in this Section.

C. Concrete mixes:
   1. Proportioning of concrete mix: Proportion mixes based on required compressive strength f'_{cr}.
   2. Mixes:
      a. Adjusting of water: After acceptance, do not change mixes without acceptance by Engineer, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
      b. Total water content of each concrete class: Not exceed those specified in Table A in this Section.
      c. Checking moisture content of fine aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
   3. Change in mixes: Submit new mix design and perform new trial batch and test program as specified in this Section.

D. Classes of concrete:
   1. Provide concrete consisting of 5 classes: Classes A, B, C, D, and CE. Use where specified or indicated on the Drawings.
   2. Weight of concrete classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
   3. Class B concrete: Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the Engineer and that do not require sulfate resistant concrete.
   4. Class C concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   5. Class D concrete: Use Class D for precast concrete items.
   6. Class CE concrete: Use Class CE for electrical conduit encasements.
   7. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete.

TABLE A1: CONCRETE				
Class	**Minimum Specified Compressive Strength f'_c at 28 Days (Pounds per Square Inch)**	**Water-to-Cementitious Materials Ratio**	**Cementitious Materials per Cubic Yard of Concrete by Weight (Pounds)**	**Slump Range (Inches)**
A	4,500	0.40 to 0.45	564 to 658	2 to 4
B (Type III cement)	4,500	0.40 to 0.45	564 to 658	2 to 4
C	2,500	Maximum 0.62	Minimum 423	3 to 6
CE	2,500	Maximum 0.62	Minimum 423	3 to 6
D	5,000	0.40 to 0.45	564 to 658	2 to 4

8. Pumped concrete: Provide pumped concrete that complies with all requirements of this Section.
9. Do not place concrete with slump outside limits indicated in Table A.
10. Classes:
    a. Classes A, C, D, and CE concrete: Make with Type II low alkali portland cement.
    b. Class B concrete: Make with Type III low alkali portland cement.
    c. Admixtures: Provide admixtures as specified in this Section.

E. Air entraining admixture:
1. Add agent to batch in portion of mixing water.
2. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Trial batches:
    a. After concrete mix designs have been accepted by Engineer, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the Engineer.
    b. Prepare trial batches using cementitious materials and aggregates proposed to be used for the Work.
    c. Prepare trial batches with sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
    d. Test cylinders: Provide cylinders having 6-inch diameter by 12-inch length and that are prepared in accordance with ASTM C31 for tests specified in this Section.
    e. Determine slump in accordance with ASTM C143.
    f. Test cylinders from trial batch:
        1) Test 8 cylinders for compressive strength in accordance with ASTM C39:
            a) Test 4 cylinders at 7 days, and 4 at 28 days.
            b) Establish ratio between 7-day and 28-day strength for mix. 7-day strength may be taken as satisfactory indication of 28-day

strength provided effects on concrete of temperature and humidity between 7-day and 28-day are taken into account.

2) Average compressive strength of 4 test cylinders tested at 28 days: Equal to or greater than required average compressive strength (f'_{cr}) on which concrete mix design is based.

g. Drying shrinkage:
   1) Prepare 5 drying shrinkage specimens in accordance with ASTM C157, except as modified in this Section.
   2) Remove drying shrinkage specimens from molds at age of 23 hours within 1 hour after trial batching, then immediately place them in water at 73 degrees Fahrenheit within 3 degrees for at least 30 minutes and then measure specimens within 30 minutes thereafter to determine original length.
      a) Then submerge specimens in saturated limewater at 73 degrees Fahrenheit within 3 degrees for moist curing.
   3) Make measurement to determine expansion expressed as percentage of original length at age 7 days.
      a) Use length at age 7 days as base length for drying shrinkage calculations.
   4) Immediately store specimens in humidity-controlled room maintained at 73 degrees Fahrenheit within 3 degrees and 50 percent within 4 percent relative humidity for remainder of test.
   5) Make and report measurements to determine shrinkage expressed as percentage of base length separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
   6) Drying shrinkage deformation:
      a) Measure drying shrinkage deformation of each specimen as difference between base length and length after drying at each test age.
      b) Measure average drying shrinkage deformation of specimens to nearest 0.0001 inch at each test age.
      c) If drying shrinkage of any specimen departs from average of test age by more than 0.0004 inch, disregard results obtained from that specimen and test another specimen.
      d) Shrinkage of trial batch concrete at 28 days drying age shall not exceed 0.045 percent maximum.

h. If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, drying shrinkage, and finishing, change concrete mix design proportions and, if necessary, source of aggregate.
   1) Perform additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.

i. Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.

j. Do not place concrete until the concrete mix design and trial batch have been accepted by Engineer.

2. Required average compressive strength:
   a. Determine required average compressive strength (f'_{cr}) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation for its corresponding specified compressive strength ($f'_{c,}$) in accordance with ACI 318 and ACI 350.

b. When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as in accordance with ACI 318 and ACI 350 and as modified in this Section.
c. Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply in preparation of concrete for the Work.
d. Provide test records with materials and proportions that are more restricted than those for the Work.
e. Specified compressive strength (f'_c) of concrete used in test records: Within 1,000 pounds per square inch of that specified for the Work.
f. When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'_{cr} from following Table B.

TABLE B
REQUIRED AVERAGE COMPRESSION STRENGTH

Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_{cr} (pounds per square inch)**
Less than 3,000	$f'_c + 1,000$
3,000 to 5,000	$f'_c + 1,200$
Over 5,000	$1.10f'_c + 700$

3. Aggregate:
   a. Testing of concrete aggregate is at Contractor's expense.
   b. Provide test reports representing samples of materials taken and tested at the following times:
      1) Not more than 60 days prior to the date on the proposed materials for concrete mixes.
      2) Not more than 60 days prior to any change in the source of aggregates, including suppliers and/or quarries.
      3) Whenever there is a significant change in aggregate quality or gradation from a previously submitted and accepted source.
   c. Sample aggregate in accordance with ASTM D75.
   d. Fine and coarse aggregates:
      1) Gradation: Test in accordance with ASTM C136. Use sieves with square openings for testing grading of aggregates.
      2) Alkali-silica reactivity:
         a) Provide fine and coarse aggregate with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260**.**
   e. Fine aggregate:
      1) Provide fine aggregate that does not contain strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C40.
      2) Provide aggregate having soundness in accordance with ASTM C33 when tested in accordance with ASTM C88.
   f. Coarse aggregate:
      1) Soundness when tested in accordance with ASTM C88: Have loss not greater than 10 percent when tested with sodium sulfate.

2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C131.

g. Fly ash:
   1) Sampling and testing: Sample and test fly ash in accordance with ASTM C311.

h. Portland cement:
   1) Determination of alkali content: In accordance with ASTM C114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Liquid evaporation retardant:
   1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant.
   2. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.
   3. Conditions which result in rapid evaporation of moisture may include one or more of the following:
      a. Low humidity.
      b. Windy conditions.
      c. High temperature.

B. Surface sealant system:
   1. Apply as recommended by manufacturer published instructions.
   2. Where concrete continues to sweat or leak, apply additional coats of surface sealant until the sweating or leaks stop.

C. Joints and bonding:
   1. As far as practicable construct concrete work as monolith.
   2. Locations of construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
   3. Time between placement of adjacent concrete separated by joints:
      a. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
         1) Slabs.
         2) Walls.
      b. Provide not less than 7 days (168 hours) between placement of upper and lower pours for the following:
         1) Walls over slabs.
         2) Slabs over walls.
         3) Slabs keyed into the sides of walls.
   4. Construction joints:
      a. Where construction joints are not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
      b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the Engineer.
      c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting.

d. Cleaning of construction joints:
    1) Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
    2) Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
    3) Provide cleanout hole at base of each wall and column for inspection and cleaning.
e. At horizontal joints: As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03600 - Grouting with a thickness of not less than 1/2 inch nor more than 1 inch.

5. Take special care to ensure that concrete is well consolidated around and against waterstops and waterstops are secured in proper position.
6. Construction and expansion Joints:
    a. Constructed where and as indicated on the Drawings.
    b. Waterstops, expansion joint material, synthetic rubber sealing compound, and other similar materials: As specified in Sections 03150 - Concrete Accessories and 07900 - Joint Sealants.
7. Repair of concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03071 - Epoxies.

D. Conveying and placing concrete:
1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without segregation of materials.
3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of day's placement.

E. Placing concrete:
1. Place no concrete without prior authorization of the Engineer.
2. Do not place concrete until:
    a. Reinforcement is secure and properly fastened in its correct position and loose form ties at construction joints have been retightened.
    b. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
    c. Forms have been cleaned and oiled as specified.
3. Do not place concrete in which initial set has occurred, or that has been retempered.
4. Do not place concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.

6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the Engineer.
8. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the work:
    a. Provide this notification in such time in advance of operations, as the Engineer deems necessary to make final inspection of preparations at location of proposed concrete placing.
    b. Place forms, reinforcement, screeds, anchors, ties, and inserts in place before notification of readiness is given to the Engineer.
    c. Depositing concrete:
        1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
        2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
        3) Do not drop concrete freely into place from height greater than 5 feet.
        4) Use tremies for placing concrete where drop is over 5 feet.
        5) Commence placement of concrete on slopes, starting at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After concrete placement begins, continue concrete placement without significant interruption. Plan and implement precautions to prevent any delay, between layers being placed, from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
13. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than 1 hour for shrinkage.

F. Consolidating concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
    c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms to leave no voids.

6. Take every precaution to make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.

G. Footings and slabs on grade:
   1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
   2. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
   3. If subgrade becomes dry prior to concrete placement, sprinkle again, without forming pools of water.
   4. Do not place concrete if subgrade is muddy or soft. Loading concrete:
   5. Green concrete:
      a. No heavy loading of green concrete will be permitted.
   6. No backfill shall be placed against concrete walls, connecting slabs, or beams until the concrete has reached the specified strength.
   7. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

H. Curing concrete:
   1. General:
      a. Cure concrete by methods specified in this Section.
      b. Keep concrete continuously moist and at a temperature of at least 50 degrees Fahrenheit for minimum of 7 days after placement.
      c. Cure concrete to be painted with water or sheet membrane.
      d. Do not use sprayed membrane curing or sealing compounds on concrete surfaces that are to receive paint or upon which any material is to be bonded.
      e. Water cure or sheet membrane cure concrete slabs that are specified to be sealed by concrete sealer.
      f. Cure other concrete by water curing or sprayed membrane curing compound at the Contractor's option.
      g. Floor slabs may be cured using sheet membrane curing.
   2. Water curing:
      a. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
      b. Each day forms remain in place count as 1 day of water curing.
      c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
      d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
      e. Flood top of walls with water at least 3 times per day and keep concrete surfaces moist at all times during 7-day curing period.
   3. Sprayed membrane curing compound:
      a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
      b. If more than 1 hour elapses after removal of forms, do not use curing compound, but use water curing for full curing period.
      c. If surface requires repairing or painting, water cure such concrete surfaces.
      d. Do not remove curing compound from concrete in less than 7 days.

e. Curing compound may be removed only upon written request by Contractor and acceptance by Engineer, stating what measures are to be performed to adequately cure concrete.
f. Take care to apply curing compound to construction joints. Apply to all surfaces along full profile of joints.
g. After curing period is complete, remove curing compound placed within construction joint profile by heavy sandblasting prior to placing any new concrete.
h. Contractor's Option: Instead of using curing compound for curing of construction joints, such joints may be water cured.
i. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
j. Apply curing compound in at least 2 coats.
k. Apply each coat in direction 90 degrees to preceding coat.
l. Apply curing compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
m. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
n. Thickness and coverage of curing compound: Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
o. The Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and also more than is customary in the trade.
p. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
q. If the Contractor desires to use curing compound other than specified curing compound, coat sample areas of concrete wall with proposed curing compound and also similar adjacent area with specified compound in specified manner for comparison:
    1) If proposed sample is not equal or better, in opinion of the Engineer, in all features, proposed substitution will not be allowed.
r. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Sheet membrane curing:
    a. Install sheet membrane as soon as concrete is finished and can be walked on without damage.
    b. Seal joints and edges with small sand berm.
    c. Keep concrete moist under sheet membrane.

I. Cold weather concreting:
1. Preparation before concreting:
    a. Remove snow, ice, and frost from the surfaces, including reinforcement against which the concrete is to be placed.
    b. The subgrade shall be free of frost before concrete placing begins.
    c. Do not place concrete around any embedment that is at a temperature below freezing and is sufficiently massive as to cause the adjacent concrete to freeze.

2. Placement of concrete:
    a. Placement temperature:
        1) The minimum temperature of concrete immediately after placement shall be as specified in Table C.
        2) The temperature of concrete as placed shall not exceed the values shown in Table C by more than 20 degrees Fahrenheit.
    b. Protection temperature:
        1) Unless otherwise specified, the minimum temperature of concrete during the protection period shall be as shown Table C.
        2) Temperatures specified to be maintained during the protection period shall be those measured at the concrete surface, whether the surface is in contact with formwork, insulation, or air.
        3) Measure the temperature with a surface measuring device accurate to 2 degrees Fahrenheit.
        4) Measure the temperature of concrete in each placement at regular time intervals as specified in the contract documents.
    c. Termination of protection:
        1) The maximum decrease in temperature measured at the surface of the concrete in a 24-hour period shall not exceed the values listed in Table C.
        2) Do not exceed these limits until the surface temperature of the concrete is within 20 degrees Fahrenheit of the ambient temperature of surrounding temperatures.
        3) When the surface temperature of the concrete is within 20 degrees Fahrenheit of the ambient temperature, all protection may be removed.

TABLE C
CONCRETE TEMPERATURE REQUIREMENTS

Least dimension of section (inches)	Minimum temperature of concrete as placed and to be maintained during the protection period (degrees Fahrenheit)	Maximum for gradual decrease in surface temperature during any 24-hour period after end of protection period (degrees Fahrenheit)
Less than 12	55	50
12 to less than 36	50	40
36 to 72	45	30
Greater than 72	40	20

3. Curing of concrete:
    a. Prevent concrete from drying during the required curing period. If water curing is used, terminate use at least 24 hours before any anticipated exposure of the concrete to freezing temperatures.
4. Protection of concrete:
    a. Combustion heaters: Vent flue gases from combustion heating units to the outside of the enclosures.
    b. Overheating and drying: Place and direct heaters and ducts to avoid areas of overheating or drying of the concrete surface.
    c. Maximum air temperature: During the protection period, do not expose the concrete surface to air having a temperature more than 20 degrees

Fahrenheit above the values shown in Table C unless higher values are required by an accepted curing method.

d. Protection against freezing:
    1) Cure and protect concrete against damage from freezing for a minimum of 3 days, unless otherwise specified.
        a) Maintain the surface temperature of the concrete as specified in Table C.
    2) During periods not defined as cold weather, but when freezing temperatures may occur, protect concrete surfaces against freezing for the first 24 hours after placing.

3.02 CONCRETE FINISHING

A. Provide concrete finishes as specified in Section 03366 - Tooled Concrete Finishing (as indicated on the Concrete Finish Schedule on the Drawings).

B. Edges of joints:
    1. Provide joints having edges as indicated on the Drawings.
    2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

C. Concrete sealer:
    1. Floors and slabs to receive concrete sealer: As specified in the Contract Documents on finish schedule.
    2. Apply concrete sealer:
        a. Apply concrete sealer at coverage rate not to exceed 300 square feet per gallon.
        b. Apply as soon as slab or floor will bear weight.
        c. Sealer:
            1) Before applying concrete sealer, sweep entire surface clean with very soft bristled brush that will not mark concrete finish and remove any standing water.
            2) Apply concrete sealer with sprayer.
            3) Use of paint rollers or mop is not acceptable.
            4) Workmen shall wear flat soled shoes which will not mark or scar concrete surface.
            5) Do not allow traffic on floors and slabs until concrete sealer has dried and hardened.

3.03 FIELD QUALITY CONTROL

A. Testing of concrete:
    1. During progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with requirements specified.
    2. Tests will be performed in accordance with ASTM C31, ASTM C39, and ASTM C172.
    3. Engineer will make and deliver test cylinders to the laboratory and testing expense will be borne by the Owner.
    4. Furnish test equipment.
    5. Make provisions for and furnish concrete for test specimens, and provide manual assistance to the Engineer in preparing said specimens.

6. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C31.
7. Sampling frequency:
    a. 1 set of test cylinders for each 150 cubic yards of each class of concrete.
    b. Minimum of 1 set of test cylinders for each class of concrete placed.
    c. Not less than 1 set of test cylinders for each half-day's placement.
    d. At least 2 sets of test cylinders for each structure.

B. Compressive strength tests:
1. Set of 3 cylinder specimens, 6 inches diameter by 12 inches long.
2. Information: Test 1 cylinder at 7 days.
3. Acceptance: Test 2 cylinders at 28 days.

C. Slump tests:
1. Test slump of concrete using slump cone in accordance with ASTM C143.
2. Do not use concrete that does not meet specification requirements in regard to slump:
    a. Remove such concrete from project site.
    b. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the Engineer.

D. Air entrainment tests:
1. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified range, and when requested to do so by the Engineer.
2. Do not use concrete that does not meet Specification requirements for air entrainment:
    a. Remove such concrete from project site.
3. Test air entrainment in concrete in accordance with ASTM C173.
4. The Engineer may at any time test percent of entrained air in concrete received on project site.

E. Enforcement of strength requirement:
1. Concrete is expected to reach a compressive strength (f'_c) equal to or greater than that the minimum specified in Table A.
2. Strength level of concrete will be considered acceptable if following conditions are satisfied:
    a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength(f'_c).
    b. No individual strength test (average of 2 cylinders) falls below specified compressive strength (f'_c) by more than 500 pounds per square inch.
3. Non-compliant strength tests:
    a. Mark non-compliant strength test reports to highlight that they contain non-complying results and immediately forward copies of test reports to all parties on the test report distribution list.
    b. Provide treatment of non-compliant concrete at no additional cost to Owner and with no additional time added to project schedule:
    c. Initial treatment may consist of additional curing and testing of the affected concrete.
        1) Provide additional curing of concrete using means and duration acceptable to the Engineer.

2) Upon completion of the additional curing, provide additional testing designated by the Engineer.
    a) Obtain and test core samples for compression strength in accordance with ASTM C42, ACI 318, and ACI 350.
    b) Provide not less than 3 cores for each affected area. Obtain Engineer's acceptance of proposed coring locations before proceeding with that work.
    c) Submit report of compression strength testing for Engineer's review.
    d) If required by the Engineer, provide additional cores and obtain petrographic examination in accordance with ASTM C856. Submit report of petrographic analysis for Engineer's review.
3) If additional curing does not bring average of 3 cores taken in affected area to at least the minimum specified compressive strength (f'_c), designate such concrete in affected area as defective.

3.04 ADJUSTING

A. Provide repair of defective concrete at no additional cost to Owner and with no additional time added to the project schedule:

B. Make repairs using approach and means acceptable to the Engineer:
1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
2. Do not patch, repair, or cover defective work without inspection by the Engineer.
3. Acceptable means may include, but are not limited to strengthening, repair, or removal and replacement.

C. Strengthening of defective concrete:
1. By addition of concrete.
2. By addition of reinforcing.
3. By addition of both concrete and reinforcing.

D. Repairs:
1. Methods of repair:
    a. Dry pack method:
        1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
        2) Smooth holes: Clean and roughen by heavy sandblasting before repair.
    b. Mortar replacement method:
        1) Use for holes too wide to dry pack and too shallow for concrete replacement.
        2) Comparatively shallow depressions, large or small, which extend no deeper than nearest surface reinforcement.
    c. Concrete replacement method:
        1) Use when holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.

2. Preparation of concrete for repair:
    a. Chip out and key imperfections in the work and make them ready for repair.
    b. Obtain Engineer's acceptance of surface preparation methods and of prepared surfaces prior to repair.
    c. Surfaces of set concrete to be repaired: First coat with epoxy bonding agent as specified in Section 03071 - Epoxies.

E. Remove and replace defective concrete.

END OF SECTION

SECTION 03366

TOOLED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Tooled concrete finishes.

1.02 QUALITY ASSURANCE

A. Mock-ups:
   1. Test panels for concrete finishes:
      a. Prepare test panels for F4 and F5 finishes and tie-hole repairs for review by Engineer.
      b. Accepted test panels serve as standard of quality and workmanship for project.
   2. Prepare test panel showing horizontal and vertical joints proposed for project for review by the Engineer. Refer to finishes specified in this Section.
   3. Test panels indicating methods for making concrete repairs: Prepare test panels for proposed repairs at beginning of project for review by Engineer:
      a. Accepted test panels serve as standard for repairs during the project.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MIXES

A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

B. Mortar mix for F5 finish: Consist of 1 part cement to 1-1/2 parts of sand which passes Number 16 screen.

PART 3 EXECUTION

3.01 CONCRETE FINISHES

A. Cement for finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Finish vertical concrete surfaces with one of the following finishes as indicated in the Finish Schedule:
   1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing compound.
   2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing compound.
   3. F3 finish: Repair defective work, remove fins, offsets, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing compound.
   4. F4 finish: Receive same finish as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar.
      a. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
      b. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
      c. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
      d. Do not let any material remain on surfaces, except that within pits and depressions.
      e. Wipe surfaces clean and moist cure.
   5. F5 finish: Receive same finish as specified for F3 finish, and, in addition, receive special stoned finish, in accordance with following requirements:
      a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
      b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of portland cement per gallon.
      c. Rub surfaces until form marks and projections have been removed.
      d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
      e. Moist cure brushed surfaces and allow to harden for 3 days:
         1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
         2) Continue curing for remainder of specified time.
      f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not.
         1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and handstoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
         2) Continue stoning until surface is hard.
         3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 60 grit carborundum stone.
         4) After stoning, continue curing until 7-day curing period is completed.

C. Finish horizontal concrete surfaces with one of the following finishes as indicated in the Finish Schedule after proper and adequate vibration and tamping:
   1. S1 finish: Screeded to grade and leave without special finish.

2. S2 finish: Smooth steel trowel finish.
3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hairbroom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish is subject to review and acceptance by the Engineer.
5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
6. S6 finish: Roughened finish: After concrete has been screeded to grade, apply a roughened finish by use of a jitterbug roller or similar device.

D. Finish concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISH SCHEDULE

A. Finish concrete surfaces as follows:
1. F4 finish for following vertical surfaces:
   a. Concrete surfaces specified or indicated to be painted.
   b. Concrete surfaces, interior or exterior, exposed to view.
2. Surfaces in open channels, basins, and similar structures:
   a. F3 finish for vertical surfaces which are normally below water surface.
   b. F4 finish for vertical surfaces located above normal water surface and exposed to view.
   c. Remove fins and fill tie holes from concrete surfaces located in closed boxes or channels where there is normally no access or passageway.
3. S1 finish for following surfaces:
   a. Projecting footings which are to be covered with dirt.
   b. Slab surfaces which are to be covered with concrete fill.
4. S2 finish for following surfaces:
   a. Tops of corbels.
   b. Tops of walls and beams not covered above in this Section.
   c. Tops of slabs not covered above in this Section.
   d. All other surfaces not specified to be finished otherwise.
5. S3 finish for following surfaces:
   a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.
6. S4 finish for following surfaces:
   a. Exterior walkways.
   b. Tops of exterior walls or beams which are to serve as walkways.
   c. Tops of exterior walls or beams which are to support gratings.
   d. Top surface of slabs for basins, channels, digesters, and similar structures.

7. S6 finish for following surfaces:
    a. Basin bottoms, or other similar slab surfaces, over which layer of basin bottom grout will be applied.

END OF SECTION

SECTION 03565

BASIN BOTTOM GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Grouting basin bottom slabs.

1.02 REFERENCES

A. International Concrete Repair Institute (ICRI):
   1. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.03 DEFINITIONS

A. Grout that has not bonded: Grout that, after placing and setting, has hollow sound when tapped with 4-foot long, nominal, 2-inch by 4-inch piece of lumber.

B. Jitterbug: An expanded metal or grate tamper designed for finishing concrete surfaces with a rough surface profile.

1.04 SUBMITTALS

A. Manufacturer's instructions:
   1. For equipment to be used in grouting basin bottom slabs:
      a. Submit grout placement instructions from manufacturer of equipment designated to operate in basin.
      b. Include in such instructions statements on limitations and precautions to be observed when using equipment for grout placement.

1.05 QUALITY ASSURANCE

A. Pre-installation conference for grouting basin bottom slabs: Schedule meeting with Engineer not less than 24 hours before planned grouting operations to discuss method of placement of grout.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for grout:
   1. Cement, sand, and water: As specified in Section 03300 - Cast-in-Place Concrete.

2.02 MIXES

A. Grout mixture:
   1. 1 part portland cement and 4-1/2 parts sand, by weight.
   2. Water content:
      a. Sufficient to allow workability for spreading grout with screeds attached to arms of equipment mechanism.
      b. Not excessive, to prevent formation of surface water, laitance, segregation, and to allow grout to stay in place after screeding.
   3. Do not use admixtures.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Basin bottom slab surface preparation:
      a. Concrete slab surfaces shall have rough texture, suitable for bonding grout.
      b. During concrete placement: finish concrete surface with jitterbug. Do not provide a smooth troweled surface.
      c. Roughen top of slab surface to an ICRI 310.2 surface profile of CSP-5 or rougher using one of the following methods:
         1) Abrasive blasting.
         2) Steel shotblasting.
         3) Ultra-high-pressure water jetting.
      d. Clean entire slab surface as required to remove dirt, oil, curing compound, laitance, dust, and other matter that may prevent proper grout bonding.
      e. Saturate concrete slabs with water for minimum of 3 days just before placing grout. At time grout is placed, concrete shall be saturated and surface damp.

B. Equipment preparation:
   1. Preparation of equipment for grouting basin bottom slabs:
      a. Setting the screeds:
         1) Bolt nominal 2-inch by 4-inch section of lumber blades on arms of equipment mechanism.
         2) Locate leading edge of lumber approximately 2 inches in front of blade and cut it parallel to centerline of arm.
         3) Securely nail nominal 2-inch by 6-inch screed board to ends of 2 by 4 lumber, in manner such that screed runs parallel to centerline of arm.
         4) Nail bent sheet metal to lower edge of screed board.
         5) Ensure that bottom of screed board is 1-1/2 inches below steel blades on arms of equipment mechanism.

3.02 APPLICATION

A. Grouting basin bottom slabs:
   1. Placement, general:
      a. Place grout in accordance with equipment manufacturer's instructions and in accordance with limitations and precautions given in such instructions.

b. Bring promptly to attention of the Engineer, conflicts between manufacturer's instructions and this Section.

2. Placing grout:
   a. Use grouting equipment to apply grout for basin bottom slabs.
   b. Perform grouting continuously without interruptions until basin slab is covered.
   c. Place ring of grout approximately 3 feet wide on outer edge of slab and gradually widened towards center following spiral pattern until basin bottom slab is covered.
   d. Unacceptable placing procedure: Following procedures will not be accepted:
      1) Grouting by circular sectors or "pie" sections.
      2) Grouting from center outward.
   e. Use finishing workers to control area immediately in front of screed boards in manner so that:
      1) Grout is installed to specified thickness.
      2) No low areas occur.
      3) No excessive amount of grout accumulates.
      4) Grout surface has uniform wood trowel finish without ridges, gouges, or other defect.
   f. Coordinate grout placement rate and number of finishing workers with travel speed of arms of equipment mechanism.
   g. Last grout area to be grouted in center may be finished by worker operating from 1 of the arms.
   h. Use misters or means acceptable to Engineer to keep grout from drying out before start of curing.
3. Following grout placement:
   a. After completion of slab grouting, allow mechanism to run continuously until there is no more danger that grout sloughing may occur.
   b. Prevent dry clumps of grout or rocks from being caught under screed board and gouging finish surface of grout.
4. Corrections:
   a. Before grout has set:
      1) Where sloughing has occurred, remove grout from sloughed areas and place grout in low areas.
      2) Repair gouges in grouted surface.
5. Curing:
   a. After grout has set, water cure grout for 7 days.
   b. Keep grout surface continuously wet for duration of curing period.

B. Tolerances:
   1. For grouting basin bottom slabs:
      a. Tolerance in elevation of finished grout surface: Plus or minus 1/8 inch.
         1) Specified tolerance is more exacting than customary industry standards for slab finish.
         2) Tolerance is required for proper operation of equipment.
      b. Thickness of grout layer:
         1) Not less than 1 inch at any point.
         2) Provide average thickness of grout as indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Inspection:
   1. Verify grout elevation tolerance on basin bottom slabs as follows:
      a. After grout has set, operate grouting equipment with blades set to clear grout surface.
      b. Under these conditions, blades shall not clear grout surface by more than 1/4 inch at any point:
         1) Excess clearance: Correct as specified in article titled "Adjusting" in this Section.

3.04 ADJUSTING

A. Grouting basin bottom slabs:
   1. After grout has set:
      a. Where clearance between blades and grouted surface exceeds tolerance specified in this Section, grind high points in grout surface using terrazzo machine until specified tolerance is met.
      b. Grout that has not bonded to concrete slab is not acceptable. Remove and replace such grout.

END OF SECTION

SECTION 03600

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   4. Epoxy grout.
   5. Grout.
   6. Non-shrink epoxy grout.
   7. Non-shrink grout.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or cube specimens).
   2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   3. C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
   5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

B. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
   1. Mix design.
   2. Material submittals.

B. Cement mortar:
   1. Mix design.
   2. Material submittals.

C. Non-shrink epoxy grout:
   1. Manufacturer's literature.

D. Non-shrink grout:
   1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Five Star Epoxy Grout.
      b. BASF Construction Chemicals, Masterflow 648 CP Plus.
      c. L&M Construction Chemicals, Inc., EPOGROUT.
   2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
   3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
   4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
   5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
   6. Compressive creep: Not exceed 0.0027 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
   7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

B. Non-shrink grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Five Star Grout.
      b. BASF Construction Chemicals, Masterflow 928.
      c. L&M Construction Chemicals, Inc., CRYSTEX.
   2. In accordance with ASTM C1107.
   3. Preportioned and prepackaged cement-based mixture.
   4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
   5. Require only addition of potable water.
   6. Water for pre-soaking, mixing, and curing: Potable water.

7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
    a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
    a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
    b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

A. Cement grout:
    1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
    2. Use same materials for cement grout that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
    4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
    1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
    2. Use same materials for cement mortar that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
    4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
    1. Proportions by weight: 1 part portland cement to 2 parts concrete sand.
        a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
        b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

D. Epoxy grout:
    1. Consist of mixture of epoxy or epoxy gel and sand.
        a. Epoxy: As specified in Section 03071 - Epoxies.
        b. Epoxy gel: As specified in Section 03071 - Epoxies.
        c. Sand: Clean, bagged, graded, and kiln-dried silica sand.
    2. Proportioning:
        a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
        b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.

E. Grout:
   1. Mix in proportions by weight: 1 part portland cement to 4 parts concrete sand.
      a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
      b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

F. Non-shrink epoxy grout:
   1. Mix in accordance with manufacturer's installation instructions.

G. Non-shrink grout:
   1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
   1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
   2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
      a. Remove loose or broken concrete.
   3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
   1. Cement grout:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Dry-patch mortar:
      a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
   4. Non-shrink epoxy grout:
      a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
   5. Non-shrink grout:
      a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
      b. Do not retemper by adding more water after grout stiffens.

B. Placement:
   1. Cement grout:
      a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
      b. Do not use cement grout that has not been placed within 30 minutes after mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Epoxy grouts:
      a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
   4. Non-shrink epoxy grout:
      a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
      b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
   5. Non-shrink grout:
      a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
      b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
   1. Cement based grouts and mortars:
      a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
      b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
   2. Epoxy based grouts:
      a. Cure grouts in accordance with manufacturers' recommendations.
         1) Do not water cure epoxy grouts.
      b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Grouting other baseplates:
   1. General:
      a. Use non-shrink grout as specified in this Section.
      b. Baseplate grouting shall take place from one side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
      c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
      d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.

2. Forms and headboxes:
    a. Build forms using material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
    c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
    d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on one side of baseplate.
    e. After grout sets, remove forms and trim back grout at 45-degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
    1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.

B. Non-shrink grout:
    1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 03926

STRUCTURAL CONCRETE REPAIR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Repairing damaged structural concrete.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or Cube Specimens).
   2. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
   3. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars).
   4. C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   5. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear.

1.03 SYSTEM DESCRIPTION

A. General: Structural repair concrete composed of cementitious material capable of being placed in formed vertical and overhead applications, and on horizontal surfaces.

B. Design requirements:
   1. Provide material suitable for performing in environments subject to corrosive attack by chlorides and sulfates, freeze/thaw cycles, low permeability, and abrasion resistant.
   2. Provide concrete repair mortar cement that is placeable from 1 inch in depth and extendable in greater depths.
   3. Concrete repair mortar shall be capable of being poured in place or troweled in place to suit the conditions encountered.

1.04 SUBMITTALS

A. Product data: Submit manufacturer's data completely describing structural repair concrete materials.

B. Certificates of Compliance.

C. Manufacturer's Instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: The manufacturer of the specified product shall have been in existence, for a minimum of 10 years.

B. Allowable tolerances: Deviation from plumb or level shall not exceed 1/8 inch within 10 feet in any direction, as determined with a 10-foot straight edge.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the manufacturer.

C. Deliver, store, and handle packaged materials in the manufacturer's original, sealed containers, each clearly identified with the manufacturer's name, and name and type of product.

D. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground, and suitably protected.

1.07 PROJECT CONDITIONS

A. Existing conditions:
   1. Hot weather: ACI 305.
   2. Cold weather: ACI 306.
   3. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural repair concrete:
   1. Manufacturers: One of the following or equal:
      a. BASF, EMACO S66-CI.
      b. Sika Corp., SikaTop 123 Plus.
   2. Compressive strength: As follows in accordance with ASTM C109:
      a. 1 day: 2,500 pounds per square inch, minimum.
      b. 7 day: 6,000 pounds per square inch, minimum.
      c. 28 day: 7,000 pounds per square inch, minimum.
   3. Bond strength by slant shear: 2,200 pounds per square inch minimum at 28 days, in accordance with ASTM C882 modified.
   4. Flexural strength: 2,000 pounds per square inch minimum at 28 days, when tested in accordance with ASTM .C293, or 770 pounds per square inch minimum at 28 days when tested in accordance with ASTM C348.
   5. Rapid freeze/thaw durability: In accordance with ASTM C666; Procedure A.
      a. Relative durability factor at 300 cycles: 95 percent minimum.
   6. Working time: 30 to 40 minutes.
   7. Color: Concrete gray.

B. Water: Potable, clean, not detrimental to concrete.

C. Form materials:
   1. Smooth finish.
   2. Brace as required to maintain tolerances.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete surfaces and exposed reinforcing are clean and free of contaminants.

3.02 PREPARATION

A. Prepare existing concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. Thoroughly clean reinforcement and other embedded items to remove loose rust and other objectionable matter.

C. Thoroughly wet wood forms, except coated plywood, and adjacent concrete at least 1 hour in advance of placing concrete; securely close cleanout end inspection ports; repeat wetting as necessary to keep forms damp.

D. Damaged concrete:
   1. Areas to be repaired shall be clean, sound, and free of contaminants.
      a. Remove all loose and deteriorated concrete by mechanical means acceptable to the Engineer.
      b. Saw cut perimeter 1/2-inch maximum.
   2. Chip concrete substrate to obtain a surface profile of 1/16 inch to 1/8 inch in depth with a new fractured aggregate surface.
      a. The area to be repaired shall be not less than 1 inch in depth.
   3. Concrete removal shall extend along the reinforcing steel to locations along the bar free of bond inhibiting corrosion, and where the bar is well bonded to surrounding concrete.

E. Use the following procedures where reinforcing steel with active corrosion is encountered:
   1. Sandblast reinforcing steel to remove all contaminants and rust.
   2. Determine section loss, splice new reinforcing steel where there is more than 15 percent loss as directed by the Engineer.
      a. If more than half the diameter of the reinforcing steel is exposed, chip out behind the reinforcing steel a minimum of 1/2 inch. The distance chipped behind the reinforcing steel must also equal or exceed the minimum placement depth of the accepted material.

F. Treat cracks in the substrate at the area of patching or overlay work as directed by the Engineer.

G. Extend existing control and expansion joints through any concrete repair.

H. Apply an epoxy-bonding agent to area to be repaired, as specified in Section 03071 - Epoxies, prior to patching concrete with polymer-modified portland cement mortar.

3.03 MIXING

A. Mix in accordance with manufacturer's mixing instructions.

3.04 INSTALLATION

A. Formed surface finishes:
   1. Smooth finish:
      a. Obtain by the use of plywood, sheet metal, or lined wood forms; no fins, pockmarks, or other irregularities shall be present in the exposed surfaces of concrete.
      b. Place no structural repair concrete without prior authorization of Engineer.

B. Verify that form materials are in place and ready to receive installation of concrete repair material.

C. Install in accordance with manufacturer's installation instructions.

D. In accordance with ACI recommendations, apply concrete repair material only when ambient conditions of moisture, temperature, humidity, and wind are favorable for curing.

E. Scrub mortar into substrate, filling all cracks, voids, and pores.

F. For new construction, finish of repaired area shall match required finish for concrete being repaired.

G. For existing concrete, finish of repair area shall match finish of concrete being repaired.

H. During the curing process, protect concrete repair from rain, wind, or freezing as required:
   1. Keep sufficient covering on hand at all times for protection of repair concrete.

3.05 CLEANING

A. Remove debris and excess material. Leave work site in a neat, clean condition.

END OF SECTION

SECTION 03931

EPOXY INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Test Method for Epoxy-Resin-Base Bonding Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   5. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer's data completely describing epoxy injection system materials and including test methods and results for strength in tension, flexure, compression and bond; flexural modulus of elasticity; coefficient of thermal expansion; and elongation.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

D. Special procedure submittals:
   1. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair, with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.
      e. Testing and inspection procedures.
      f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall include product identification, batch numbers, and shelf life information.

B. Store materials off the ground and away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before mixing and using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Repair materials shall be free of chlorides or alkalis (except for those attributed to water).
   2. To ensure compatibility of materials and methods, a single manufacturer shall produce and provide all products used together in a single area of concrete repair.
   3.

B. Manufacturers: One of the following or equal:
   1. BASF Building Systems, MasterInject 1500 (formerly Concresive Standard LVI).
   2. Sika Chemical Corp., Sikadur 35 Hi-Mod LV.
   3. .

C. Epoxy:
   1. In accordance with ASTM C881, Types I, II and IV, Grade 1, Class C.
   2. Water-insensitive 2-component low viscosity, epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Table 1 - Epoxy, Physical Properties		
Characteristic	Test Method	Required Results, minimum(1,2)
Viscosity (mixed)	--	250 - 375 centipoise
Tensile Strength	ASTM D638	7,500 pounds per square inch
Tensile Elongation at Break	ASTM D638	1 percent
Compressive Strength	ASTM D695	11,000 pounds per square inch
Compressive Modulus	ASTM D695	2.5×10^5 pounds per square inch.
Bond Strength, slant shear, hardened concrete to hardened concrete	ASTM C882	1500 pounds per square inch at 2 days at minimum 73 degrees Fahrenheit. Concrete shall fail before failure of epoxy.
Heat Deflection Temperature	ASTM D648	124 degrees Fahrenheit
Notes:		
1)	Properties for mixes with neat epoxy.	
2)	Results after 7-day cure at temperature between 72 and 78 degrees Fahrenheit, unless otherwise noted.	

2.02 EQUIPMENT

A. Injection pump:
   1. Use positive displacement injection pump with interlock to provide in-line mixing and metering system for 2 component epoxy.
   2. Use pressure hoses and injection nozzle designed to properly mix of 2 components of epoxy.
   3. Standby injection unit may be required.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperature and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing epoxy injection.
   2. Sweep or clean area in vicinity of cracks that will be injected with epoxy. Leave area in generally clean condition after epoxy injection is complete.
   3. Clean cracks so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix epoxy in accordance with manufacturer's installation instructions.
   2. Do not use solvents to thin epoxy system materials introduced into cracks or joints.

C. Injection:
   1. Apply adequate surface seal to crack to prevent leakage of epoxy.
   2. Establish injection points at distance along crack not less than thickness of cracked member.
   3. Crack injection sequence:
      a. Inject epoxy into crack or joint at first port with sufficient pressure to advance epoxy to adjacent port. Start at lowest port along the injection line and work upwards.
      b. Seal original port and shift injection to next adjacent port where epoxy appears.
      c. Continue port-to-port injection until crack has been injected for its entire length.
      d. For small amounts of epoxy, or where excessive pressure developed by injection pump might further damage structure, premixed epoxy and use hand caulking gun to inject epoxy if acceptable to the Engineer.
      e. Seal ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out.
      f. After epoxy injection is complete, remove surface seal material, and refinish concrete in area where epoxy was injected to match existing concrete. Leave finished work and work area in a neat, clean condition.

3.03 FIELD QUALITY ASSURANCE

A. Provide Contractor quality control as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
   1. Submit records of inspections and tests to Engineer within 24 hours after completion.

C. Manufacturer's services.
   1. Pre-installation meeting: Provide manufacturer's technical representative to attend pre-installation meeting specified in this Section.

3.04 FIELD QUALITY CONTROL

A. Provide Owner's quality assurance for the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections special tests, and structural observation:
   1. Not required.

C. Field inspections:
   1. Preparation.
      a. Review manufacturer's product data and installation instructions.
   2. Required inspections.
      a. Observe surfaces to be injected for temperature and moisture conditions and for surface preparation.
      b. Observe conditioning and mixing of epoxy resin components.

c. Observe injection procedures for filling cracks.

3. Records of inspections:
   a. Provide record of each inspection.
   b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Rework surface finishes that do not match surrounding concrete to the satisfaction of Engineer at no additional cost to Owner.

END OF SECTION

SECTION 03933

HYDROPHILIC AND HYDROPHOBIC FOAM POLYURETHANE RESIN INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrophilic foam polyurethane resin injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D3574 - Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: Submit manufacturer's data completely describing polyurethane resin injection system materials.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.
   3. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by the manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.
      e. Testing and inspection procedures.

f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall indicate product identification, batch numbers, and shelf life.

B. Store materials off the ground, away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Polyurethane resin injection systems that will be in direct contact with water after the Work is completed shall comply with applicable federal, state, or local regulations.
      a. Confirm compliance by submitting documentation that products have been tested and listed in accordance with NSF-61 requirements. Provide testing by a nationally recognized agency acceptable to Engineer.
   2. Repair materials shall be free of chlorides or alkalis (except for those attributed to water).
   3. To ensure that compatibility of materials and methods, a single manufacturer shall produce and provide all products used together in a single area of concrete repair.

B. Manufacturers: One of the following or equal:
   1. BASF, Building Systems, MasterInject 1210 IUG (Formerly Concresive 1210IUG).
   2. Sika Corp., SikaFix HH LV.
   3. BASF Building Systems, MasterInject 1230 IUG.
   4. SealBoss Corp., 1510 Water Stop Foam.

C. Resin:
   1. Water-insensitive 1-part low-viscosity polyurethane resin adhesive material containing 100-percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Physical Characteristic	Required Results
Viscosity	400-600 CPS at 70 degrees Fahrenheit
Flash Point	greater than 200 degrees Fahrenheit

Physical Characteristic	Required Results
Corrosiveness	Non-corrosive
Reaction Time	75 - 90 seconds at 80 degrees Fahrenheit
Toxicity	Non-Toxic

a. Uncured:
b. Cured foam (1:1):

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D3574	150 - 400 pounds per square inch
Elongation	ASTM D3574	400 - 1200 percent

2.02 EQUIPMENT

A. Pump unit:
   1. Furnish unit to be used for injection that is positive displacement type with interlock to provide in-line mixing and metering system for 1 component polyurethane resin.
   2. Furnish pressure hoses and injection nozzle of such design as to allow proper mixing of polyurethane resin.
   3. Standby injection unit may be required.

B. Resin pump: Operating pressure in excess of 2,000 pounds per square inch with a variable pressure control trigger mechanism with attached pressure gauge, on the downstream end of the material supply hose.

C. Water pump: High-pressure water blaster capable of 1,000 pounds per square inch or higher pressure.

D. Incidentals: To be determined by site conditions and Contractor. See Installation Bulletin 6I12 - Urethane Injection, from BASF Construction Chemicals, LLC.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperatures and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing urethane injection.
   2. Sweep or clean area in vicinity of cracks and joints that will be injected with polyurethane resin.
   3. Clean cracks and joints so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure polyurethane resin materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix urethane in accordance with manufacturer's installation instructions.

C. Injection:
   1. Apply adequate surface seal to crack or joint to prevent escape of polyurethane resin.
   2. Establish injection ports along seal at a spacing not greater than the thickness of cracked member.
   3. Injection:
      a. Inject polyurethane resin into crack or joint at first port with sufficient pressure to advance polyurethane resin to adjacent port. Start at lowest port along the injection line and work upwards.
      b. Seal original port and shift injection to next adjacent port at which polyurethane resin appears.
      c. Continue port-to-port injection until each crack or joint has been injected for its entire length.
   4. For small amounts of polyurethane, or where excessive pressures developed by injection pump unit might further damage the structure, material mixed and installed with a hand caulking gun may be used if acceptable to the Engineer.
   5. Seal ports, including adjacent locations where polyurethane resin seepage occurs, as necessary to prevent drips or run out.
   6. After injection is complete, remove surface seal material and re-finish concrete in the area where the polyurethane was injected to match surrounding concrete. Leave finished work and work area in a neat and clean condition.

3.03 FIELD QUALITY CONTROL

A. Provide Contractor quality control as specified in Section 01450 - Quality Control.

B. Field inspections and tests:
   1. Submit records of inspections and test to Engineer within 24 hours after completion.

C. Manufacturer's services.
   1. Pre-installation meeting. Provide manufacturer's technical representative to attend pre-installation meeting specified in Section 01450 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide Owner quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Not required.

C. Field inspections:
   1. Preparation.
      a. Review manufacturer's product data and installation instructions.

2. Required inspections:
    a. Observe surfaces to be injected for temperature and moisture conditions.
    b. Observe conditioning and preparation of urethane resin.
    c. Observe injection procedures for filling cracks.
3. Records of inspections:
    a. Provide record of each inspection.
    b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Cracks, after injection, shall show no evidence of running or seeping water. Re-inject as necessary to provide watertight seal at no additional cost to Owner.

B. Rework surface finishes that do not match surrounding concrete to the satisfaction of the Engineer at no additional cost to Owner.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners and structural hardware:
      a. All thread rods.
      b. All thread rods, high strength.
      c. High-strength bolts.
   3. Welding.
   4. Bolting.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

B. American Iron and Steel Institute (AISI):
   1. Steel and stainless steel alloys (“types”) as indicated.

C. American Welding Society (AWS):
   1. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   2. A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   3. A5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   4. D1.1 - Structural Welding Code - Steel.
   5. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   6. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   7. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

9. A489 - Standard Specification for Carbon Steel Lifting Eyes.
10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
13. A992 - Standard Specification for Structural Steel Shapes.
14. F436 - Standard Specification for Hardened Steel Washers.
15. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
16. F594 - Standard Specification for Stainless Steel Nuts.
17. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
18. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
19. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
20. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. Research Council on Structural Connections (RCSC):
   1. Specification for Structural Joints Using High-Strength Bolts (RCSC Specification).

1.03 DEFINITIONS

A. Snug-tight: At bolted joints, the tightness attained with a few impacts of an impact wrench, or by the full effort of an ironworker using a spud wrench to bring the connected plies into firm contact.

B. Stainless steel related terms:
   1. Descaling: Removal of heavy, tightly adherent oxide films resulting from hot-forming, heat-treatment, welding, and other high-temperature operations.
   2. Pickling: Chemical descaling of stainless steel using aqueous solutions of nitric and hydrofluoric acid, or various proprietary formulations as specified.
   3. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel’s protective passive film.

1.04 SUBMITTALS

A. Product data:
   1. Welding electrodes for field welds: Electrode manufacturer's data.
   2. Compressible-washer-type direct tension indicators: Manufacturer’s detailed installation instructions including:
      a. Requirements for type and frequency of pre-installation verification.
      b. Requirements for coordination with regular washers.
      c. Instructions for assembling and tightening the joint so that work progresses from the most rigid part until the connected plies are in firm contact.

3. Stainless steel: Fabricator name and qualifications, member dimensions and structural section properties, and specifications and procedures used for pickling and passivating members.

B. Shop drawings:
   1. Fabrication and erection drawings.

C. Quality control submittals:
   1. Welding procedure specifications (WPS) in accordance with AWS D1.1 and D1.6.
      a. Submit WPS for each type of welded joint used, whether prequalified or qualified by testing.
         1) State electrode manufacturer and specific electrodes used.
         2) Indicate required AWS qualification for joint.
      b. Submit WPS with shop drawings that indicate those welds.
      c. Submit Procedure Qualification Record (PQR) in accordance with AWS D1.1 and D1.6 for welding procedures qualified by testing.
   2. Welder qualifications: For each welding process and position:
      a. Welder's qualification certificates.
      b. Contractor's statement that certificate will be "in effect" at the time(s) welding will be performed based on the "Period of Effectiveness" provisions of AWS D1.1 and D1.6.
   3. Steel fabricator's AISC certification.

D. Test reports:
   1. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

1.05 QUALITY ASSURANCE

A. Certification:
   1. Steel fabricators shall be certified by the AISC or other certification acceptable to the Engineer and the building official having jurisdiction.

B. Welding:
   1. Perform welding of structural metals in accordance with AWS D1.1 and D1.6 using welders who have current AWS qualification certificate for the process, position, and joint configuration to be welded.
   2. Make Welding Procedure Specifications available at the locations where welding is performed.
   3. Notify Engineer at least 24 hours before starting shop or field welding.
   4. Engineer may check materials, equipment, and qualifications of welders.
   5. Remove welders performing unsatisfactory Work, or require requalification.
   6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
   7. Contractor shall bear costs of retests on defective welds.
   8. Contractor shall also bear costs in connection with qualifying welders.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

2.02 FASTENERS AND STRUCTURAL HARDWARE

A. General:
   1. Materials: Of domestic manufacture.
   2. Where fasteners and hardware are specified to be galvanized, hot-dip galvanize in accordance with ASTM A153 or ASTM F2329, unless otherwise specified.

B. All thread rods:
   1. Carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
      b. High strength all thread rods: In accordance with ASTM F1554, Grade 55.
      c. Nuts: ASTM A194.
      d. Washers: ASTM F436.
   2. Galvanized carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
      b. High strength galvanized all thread rods: In accordance with ASTM F1554, Grade 55, and galvanized in accordance with ASTM F2329**.**
      c. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
      d. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.
   3. Stainless steel:
      a. Units descaled, pickled, and passivated as specified in “Fabrication” in this Section.
      b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
      c. Alloy Type 304 or Type 316 as indicated on the Drawings.
      d. Type 304:
         1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
         2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
         3) Washers: Type 304 stainless steel.
      e. Type 316:
         1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
         2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
         3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

D. High-strength bolts:
   1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators. Carbon steel - Uncoated:
      a. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1**.**
      b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
      c. Washers:
         1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1. Flat circular washers unless otherwise indicated on the Drawings.
         2) Adjacent to long slotted holes: Fabricated from 5/16-inch thick plate conforming to ASTM A36.
      d. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
         1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1.
         2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852.
   2. Carbon steel - Galvanized:
      a. Bolt and nut assemblies fabricated, galvanized, tested for rotational capacity, and shipped accordance with the provisions ASTM F3125, Grade A325and the RCSC Specification.
      b. Bolts, nuts, and washers: Hot-dip galvanized in accordance with ASTM F2329.
      c. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1 and galvanized as specified.
      d. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade DH, galvanized as specified, and lubricated in accordance with ASTM A563, Supplementary Requirement S1 to minimize galling.
      e. Washers:
         1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1 and galvanized as specified. Flat circular washers unless otherwise indicated on the Drawings.
         2) Adjacent to long slotted holes: 5/16-inch thick plate washer fabricated from steel conforming to ASTM A36, and galvanized in accordance with ASTM A123.
      f. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
         1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1, with mechanically deposited zinc coating conforming to ASTM B695, Class 55.
         2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852 with mechanically deposited zinc coating conforming to ASTM B695, Class 55.

E. Stainless steel bolts (for use in stainless steel structures):
   1. General:
      a. Bolts and nuts shall be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship bolts with properly fitting nuts attached.

b. Units descaled, pickled and passivated as specified in “Fabrication."
2. Alloy: Type 304 or Type 316 to match alloy of structural members being connected.
3. Type 304:
   a. Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
   b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
   c. Washers: Type 304 stainless steel.
4. Type 316:
   a. Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
   b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
   c. Washers: Type 316 stainless steel.
5. Welded studs: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.03 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.04 GALVANIZED SURFACE REPAIR

A. Manufacturers: The following or equal:
   1. Jelt, Galvinox.

2.05 THREAD COATING

A. Manufacturers: One of the following or equal:
   1. Bostik, Never-Seez.
   2. Oil Research, Inc., WLR No. 111.

2.06 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.07 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. Round off sharp and hazardous projections and grind smooth.
   4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
   5. Take responsibility for correct fitting of metalwork.
   6. Welded connections:
      a. Comply with AWS requirements for the metals to be welded.

b. Weld only in accordance with approved Welding Procedure Specifications.
c. Keep Welding Procedure Specifications readily available for welders and inspectors during fabrication processes.

B. Stainless steel shapes and assemblies:
1. For structural members such as W shapes, S shapes, channels, angles, and similar rolled shapes not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
a. Fabricate shapes using laser-fused, full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as that of members indicated on the Drawings.
b. Fabricate shapes from dual grade stainless steel.
c. Fabricate beams and channels to ASTM A6 tolerances.
d. Manufacturers: The following or equal:
1) Stainless Structural, LLC.
2. Cleaning and passivation:
a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.
b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
d. Pre-clean, chemically de-scale (“pickle”), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380.
1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.
2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.
e. Inspect after cleaning using methods specified for “gross inspection” in ASTM A380.
f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

C. Galvanized carbon steel:
1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
3. Re-straighten galvanized items that bend or twist during galvanizing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
   1. Fabricate structural and foundry items to true dimensions without warp or twist.
   2. Form welded closures neatly and grind off smooth where weld material interferes with fit or is unsightly.
   3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
   4. Do not shift out of alignment, re-drill, re-shape, or force fit fabricated items.
   5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
   6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
   7. Erect structural steel in accordance with AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
   9. Round off sharp or hazardous projections and grind smooth.
   10. Paint or coat steel items as specified in Sections 09960 - High-Performance Coatings.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling.
   1. Segregate stainless steel from iron.
   2. Tools and handling devices.
      a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
      b. Do not use tools that have been contaminated by contact with iron.
      c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.
   2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding: Carbon steel:
   1. General: In accordance with AWS D1.1:
      a. Weld ASTM A36 and A992 structural steel, and ASTM A500 and A501 structural tubing with electrodes in accordance with AWS A5.1, using

E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes:

b. Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.

E. Welding - stainless steel:
   1. General: In accordance with AWS D1.6.
   2. Passivation of field-welded surfaces:
      a. Provide cleaning, pickling and passivating as specified under “Fabrications” of this Section. Clean using Derustit Stainless Steel Cleaner, or equal.

F. Interface with other products:
   1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

G. Fasteners: General:
   1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
   2. Anchor bolts and anchor rods: Install as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snug-tight" condition.
   3. All thread rods in drilled holes bonded to concrete with adhesive: Install as specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

H. Fasteners: High-strength carbon steel bolts:
   1. Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Provide pre-tensioned joints at bolted connections, except where slip-critical or snug-tight connections are indicated on the Drawings.
   3. Joints: Slip-critical.
      a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
      b. Furnish hardened flat washers in accordance with ASTM F436:
         1) On outer plies with slotted holes.
         2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
         3) Under element, nut, or bolt head, turned in tightening.
      c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
      d. Tighten bolts to full pretension.
   4. Joints: Pre-tensioned.
      a. Joint preparation, assembly, and tightening shall be as specified for slip-critical connections, except that the requirements for un-coated faying surfaces shall not apply.

5. Joints: Snug-tight:
    a. Install bolts with washers where required in accordance with RCSC Specification.
    b. Tighten bolts to bring the connected plies into firm contact. Tightening shall progress systematically beginning with the most rigid part of the joint. More than 1 cycle through the bolt pattern may be required to achieve this condition.
    c. Verify adequate tightening of bolts by visual observation to confirm that washers have been installed at locations required in accordance with RCSC Specification, and that the plies of the connected parts have been brought into firm contact.

I. Fasteners: Stainless steel bolts:
    1. Connections shall be snug-tight joints unless otherwise indicated on the Drawings.
    2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.
    3. Rotate nuts using a slow, smooth action without interruptions. Avoid over-tightening.

3.03 FIELD QUALITY CONTROL

A. Provide quality control as specified in Section 01450 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
    1. Provide as specified in Section 01455 - Special Tests and Inspections.

END OF SECTION

SECTION 05140

STRUCTURAL ALUMINUM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

B. American Welding Society (AWS):
   1. A5.10 - Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
   2. D1.2 - Structural Welding Code - Aluminum.

1.03 SUBMITTALS

A. Quality control submittals:
   1. Test Reports: Certified copies of mill tests or reports from a recognized commercial laboratory including chemical and tensile properties of each shipment of structural metal or part thereof having common properties. Tests and analyses shall be made in accordance with applicable ASTM Standards.
   2. Welder’s certificates.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Notify Engineer 24 hours minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work or that require requalifying.
   5. Engineer may use gamma ray, magnetic particle dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall bear costs in connection with qualifying welders.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.

B. Structural aluminum: ASTM B308, Alloy 6061-T6.

C. Extruded aluminum: ASTM B221, Alloy 6063-T42.

D. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

E. Miscellaneous materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. Conform to applicable ASTM Standards for materials not otherwise specified.

2.02 FABRICATION

A. Aluminum layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.000013 per degree of Fahrenheit.

B. Cutting aluminum:
   1. Material 1/2-inch thick or less: Shear, saw, or cut with a router.
   2. Material more than 1/2-inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly:
      a. Make finished diameter of holes for bolts 1/16-inch maximum larger than nominal bolt diameter.
      b. Make holes cylindrical and perpendicular to principal surface.
      c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum forming and assembly:
   1. Do not heat structural aluminum, except as follows:
      a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
      b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding aluminum:
   1. Perform welding of aluminum in accordance with AWS D1.2.

2. Weld aluminum in accordance with the following:
    a. Preparation:
        1) Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
        2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
        3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
        4) Suitably prepare edges to ensure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
    b. Filler metal: Aluminum alloys conforming to the requirements of AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
    c. Perform welding of structures which are to be anodized using filler alloys which will not discolor when anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
    d. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
    e. Do not use welding process that requires use of a welding flux.
    f. Neatly make welded closures.
    g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
    h. Make welds full penetration welds unless otherwise indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and true to level.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with other products:
   1. Where aluminum comes in contact with dissimilar metals, use stainless steel bolts or anchors and separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Coat those parts of aluminum that will be cast into concrete or that will be in contact with concrete, grout, masonry, wood, or other materials that will cause the aluminum to corrode, as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 05190

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in anchors and fasteners:
      a. Anchor bolts.
      b. Anchor rods.
      c. Deformed bar anchors.
      d. Welded studs.
   2. Post-installed steel anchors and fasteners:
      a. Concrete anchors.
   3. Appurtenances for anchoring and fastening:
      a. Thread coating for threaded stainless steel fasteners.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   7. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   8. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   9. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

10. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
11. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
12. F436 - Standard Specification for Hardened Steel Washers.
13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
14. F594 - Standard Specification for Stainless Steel Nuts.
15. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
16. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.

B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.

C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.

D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.

E. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.

F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
1. Corrosive locations: Describes interior and exterior locations as follows:
    a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
    b. Exterior and interior locations at the following treatment structures:
        1) Water treatment facilities: Liquids stream:
            a) As indicated on the drawings.
        2) Water treatment facilities: Solids stream:
            a) As indicated on the drawings.
2. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
    a. Exterior portions of buildings and structures.
    b. Liquid-containing structures:
        1) Locations at and below the maximum operating liquid surface elevation.

2) Locations above the maximum operating liquid surface elevation and:
a) Below the top of the walls containing the liquid.
b) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).

c. Liquid handling equipment:
1) Bases of pumps and other equipment that handles liquids.

d. Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.

e. Other locations indicated on the Drawings.

3. Other locations:
a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 SUBMITTALS

A. General:
1. Submit as specified in Section 01330 - Submittal Procedures.
2. Submit information listed for each type of anchor or fastener to be used.

B. Action submittals:
1. Product data:
a. Cast-in anchors:
1) Manufacturer's data including catalog cuts showing anchor sizes and configuration, materials, and finishes.

b. Post-installed anchors:
1) For each anchor type, manufacturer's data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.

2. Samples:
a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.

3. Certificates:
a. Cast-in anchors:
1) Mill certificates for steel anchors that will be supplied to the site.

b. Post-installed anchors:
1) Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.

4. Test reports:
a. Post-installed anchors: For each anchor type used for the Work:
1) Current ICC-ES Report (ESR**)** demonstrating:
a) Acceptance of that anchor for use under the building code specified in Section 01410 - Regulatory Requirements.

5. Manufacturer's instructions:
a. Requirements for storage and handling.
b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
c. Requirements for inspection or observation during installation.

6. Qualification statements:
    a. Post-installed anchors: Installer qualifications:
        1) Submit list of personnel performing installations and include date of manufacturer's training for each.

1.05 QUALITY ASSURANCE

A. Qualifications:
    1. Post installed anchors shall be in accordance with building code specified in Section 01410 - Regulatory Requirements.
    2. Installers: Post-installed mechanical anchors:
        a. Installations shall be performed by trained installers having at least 3 years of experience performing similar installations with similar types of anchors.

B. Special inspection:
    1. Provide special inspection of post-installed anchors as specified in Section 01455 - Special Tests and Inspections and this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

C. Protect anchors from weather and moisture until installation.

1.07 PROJECT CONDITIONS

A. As specified in Section 01610 - Project Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
    1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
        a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
        b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
    2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact Engineer for clarification.

3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Description:
      a. Straight steel rod having 1 end with an integrally forged head, and 1 threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
      b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer.
         1) Rods or bars with angle bend for embedment in concrete (i.e., “L” or “J” shaped anchor bolts) are not permitted in the Work.
   2. Materials:
      a. Ship anchor bolts with properly fitting nuts attached.
      b. Type 316 stainless steel:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
         2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
         3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         4) Washers: Type 316 stainless steel.
      c. Type 304 stainless steel:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
         2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
         3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         4) Washers: Type 304 stainless steel.
      d. Galvanized steel:
         1) Hot-dip galvanized coating in accordance with ASTM F2329.
         2) Bolt: ASTM F1554, Grade 36, heavy hex, coarse thread.
         3) Nuts: ASTM A563, Grade A, heavy hex, threads to match bolt.
         4) Washers: ASTM F436, Type 1.

B. Anchor rods:
   1. Description: Straight steel rod having threads on each end or continuously threaded from end to end. One threaded end is fitted with nuts or plates and embedded in concrete to the effective depth indicated on the Drawings, leaving the opposite threaded end to project clear of the concrete face as required for the connection to be made at that location.
   2. Materials:
      a. Stainless steel: Type 316:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.

2) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
4) Washers: Type 316 stainless steel.
5) Plates (embedded): ASTM A240.

b. Stainless steel: Type 304:
1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
2) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads or rods.
4) Washers: Type 304 stainless steel.
5) Plates (embedded): ASTM A240.

c. Galvanized: steel:
1) Hot-dip galvanized with coating in accordance with ASTM F2329.
2) Rod: ASTM F1554, Grade 36, coarse thread.
3) Nuts: ASTM A563, Grade A, threads to match rod.
4) Washers: ASTM F436, Type 1.
5) Plates (embedded): ASTM A36.

C. Welded studs:
1. Description: Anchor with forged head for embedment into concrete on one end, and welding ferrule for attachment to steel on the other. Welded to steel members or plates to provide anchorage for steel connections to concrete.
2. Acceptance criteria:
a. Welded studs in accordance with AWS D1.1, Type B.
3. Manufacturers: One of the following or equal:
a. Nelson Stud Welding Co., H4L Concrete Anchors or S3L Shear Connectors as indicated on the Drawings.
b. Stud Welding Products, Headed Concrete Anchors (HCA) or Headed Shear Connectors (HSC) as indicated on the Drawings.
4. Materials:
a. Stainless steel: Type 316L.
b. Stainless steel: Type 304L.
c. Galvanized steel:
1) Hot-dip galvanized after fabrication with coating in accordance with ASTM A123.
2) Steel: Carbon steel in accordance with ASTM A108 with 50,000 pounds per square inch minimum yield strength, and 60,000 pounds per square inch minimum tensile strength.

D. Steel plates or shapes for fabrications including assemblies with welded studs or deformed bar anchors:
1. Stainless steel: Type 316L or Type 304L:
a. Plates (embedded): ASTM A240.
2. Galvanized steel:
a. Hot dip galvanized in accordance with ASTM A123.
b. Steel: ASTM A36.

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410 - Regulatory Requirements. Reports prepared by other recognized evaluation agencies may be submitted for consideration if acceptable to the Engineer and to the authority having jurisdiction.
      a. Conditions of use: The acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.
         2) To resist short-term loads due to wind forces.
         3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.
   2. Substitutions: When requesting product substitutions, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section.
      a. Calculations shall be prepared by and shall bear the signature and seal of a Civil or Structural Engineer licensed in the State of Utah.
      b. Decisions regarding the acceptability of proposed substitutions shall be at the discretion of the Engineer.

B. Concrete anchors:
   1. Description. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torqueing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. (Sometimes referred to as “expansion anchors” or “wedge anchors.”)
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
   2. Concrete anchors for anchorage to concrete:
      a. Acceptance criteria:
         1) Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
         2) Concrete anchor performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
      b. Manufacturers: One of the following or equal:
         1) Hilti, Kwik Bolt TZ Expansion Anchor.
         2) DEWALT/Powers, PowerStud.

3) Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.

c. Materials. Integrally threaded stud, wedge, washer, and nut:

1) Stainless steel: Type 316.

a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.

2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

C. Flush shells:

1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
2. Flush shell anchors are not permitted in the Work.

D. Sleeve anchors:

1. Description: Post-installed, torque-controlled anchor assembly consisting of an externally threaded stud with a spacer sleeve near the surface of the base material, and an expansion sleeve on the lower part of the stud. The expansion sleeve is forced outward by torqueing of the center stud to transfer load.
   a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials in order to develop holding power.
2. Sleeve anchors for anchorage to concrete:
   a. Acceptance criteria:
      1) Sleeve anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      2) Sleeve anchor performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
   b. Manufacturers: One of the following or equal:
      1) Hilti, HSL-3 Heavy Duty Expansion (sleeve) Anchor.
      2) DEWALT/Powers, Power Bolt+ Heavy Duty Sleeve Anchor.
   c. Materials:
      1) Stainless steel: Not available.
      2) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

E. Undercut concrete anchors:

1. Description: Post-installed concrete anchor that develops tensile strength from mechanical interlock provided by creation of an undercut “key” at the embedded end of the anchor. The undercut may be achieved with a special drill before anchor installation, or by the anchor itself during installation.
2. Acceptance criteria:
   a. Acceptance criteria:
      1) Undercut concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for

short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and ICC ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).

2) Undercut anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.

b. Use pre-setting units. Manufacturers: One of the following or equal:
c. Hilti, HDA (carbon steel) or HDA-R (stainless steel) Undercut Anchor.
d. Powers Fasteners, Atomic+ Undercut Anchor.
e. Simpson Strong-Tie, Torq-Cut Anchor.
f. USP Structural Connectors, DUC-L Undercut Anchors.

3. Materials:
   a. Stainless steel: Corrosive, wet, and moist and locations: Type 316.
   b. Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
   1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
   2. Plastic sleeves:
      a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
      b. Manufacturers: The following or equal:
         1) Portland Bolt & Manufacturing Co.

B. Isolating sleeves and washers:
   1. Manufacturers: One of the following or equal:
      a. Central Plastics Co.
      b. Allied Corrosion Industries.
   2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
   3. One sleeve required for each bolt.
   4. Washers: The inside diameter of all washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter.
      a. Proper size to fit bolts.
      b. Two 1/8-inch thick steel washers for each bolt.
      c. G3 Phenolic: 2 insulating washers are required for each bolt:
         1) Thickness: 1/8 inch.
         2) Base material: Glass.
         3) Resin: Phenolic.
         4) Water absorption: 2 percent.
         5) Hardness (Rockwell): 100.
         6) Dielectric strength: 450 volts per mil.
         7) Compression strength: 50,000 pounds per square inch.
         8) Tensile strength: 20,000 pounds per square inch.
         9) Maximum operating temperature: 350 degrees Fahrenheit.

C. Coating for repair of galvanized surfaces:
   1. Manufacturers: The following or equal:
      a. Jelt, Galvinox.

D. Thread coating: For use with threaded stainless steel fasteners:
   1. Manufacturers: One of the following or equal:
      a. Bostik, Never-Seez.
      b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION: GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
   1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
   2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Take special care to protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
   1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
   2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION: CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors.
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.

b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.

2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
2. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment.

C. Anchor rods:
1. Install as specified for anchor bolts.

D. Concrete inserts:
1. Provide inserts with minimum clear concrete cover not less than that specified for reinforcing bars.

E. Welded studs:
1. Butt weld to steel fabrications with automatic stud welding gun as recommended by the manufacturer.
2. Ensure that butt weld develops full strength of the stud.

3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

3.05 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

A. General:
1. Install anchors in accordance with the manufacturer’s instructions, ACI 355.2, the anchor’s ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
3. After anchors have been positioned and inserted into concrete or masonry, do not:
a. Remove and reuse/reinstall anchors.

b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
   1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
   2. Accurately locate holes:
      a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
      b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
   3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
      a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.
   4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
   5. Drill using anchor manufacturer's recommended equipment and procedures:
      a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
         1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
         2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.
   6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
   7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
      a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
      b. Repeat cleaning process as required by the manufacturer's installation instructions.
      c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in full compliance with the manufacturer's installation instructions.
   1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
Nominal Diameter	**Minimum Effective Embedment Length**		**Minimum Member Thickness**
	In Concrete	**In Grouted Masonry**	
3/8 inch	2 1/2 inch	2 5/8 inch	8 inch
1/2 inch	3 1/2 inch	3 1/2 inch	8 inch
5/8 inch	4 1/2 inch	4 1/2 inch	10 inch
3/4 inch	5 inch	5 1/4 inch	12 inch

E. Flush shell anchors:
1. Flush shell anchors are not permitted in the Work.
2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.

F. Sleeve anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Sleeve Anchors			
	Minimum Effective Embedment Length		**Minimum Member Thickness**
Nominal Diameter	**In Concrete**	**In Grouted Masonry**	
M8 (1/2 inch)	70 mm (2 3/4 inch)	Not accepted	100 mm (8 inch)
M10 (5/8 inch)	76 mm (3 inch)	Not accepted	250 mm (10 inch)
M12 (3/4 inch)	80 mm (3 1/4 inch)	Not accepted	300 mm (12 inch)

2. Install with the sleeve fully engaged in the base material.

G. Screw anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Screw Anchors			
	Minimum Effective Embedment Length		**Minimum Member Thickness**
Nominal Diameter	**In Concrete**	**In Grouted Masonry**	
3/8 inch	2 1/2 inch	3 1/4 inch	8 inch
1/2 inch	3 1/4 inch	4 1/2 inch	8 inch
5/8 inch	4 inch	5 inch	10 inch
3/4 inch	5 1/2 inch	6 1/4 inch	12 inch

2. Install screw anchors using equipment and methods recommended by the manufacturer. Continue driving into hole until the washer head is flush against the item being fastened.

H. Undercut concrete anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Undercut Anchors			
Nominal Diameter (bolt)	**Minimum Effective Embedment Length**		**Minimum Member Thickness(1)**
	In Concrete	**In Grouted Masonry**	
M10 (3/8 inch)	100 mm (4 inch)	Not accepted	200 mm (8 inch)
M12 (1/2 inch)	125 mm (5 inch)	Not accepted	350 mm (14 inch)
M16 (5/8 inch)	190 mm (7 1/2 inch)	Not accepted	460 mm (18 inch)
M20 (7/8 inch)	250 mm (10 inch)	Not accepted	510 mm (20 inch)
Notes: (1) Thickness indicated is for pre-set units. If through-set units are accepted, obtain minimum member thickness requirements from the Engineer.			

2. Installations of undercut anchors shall not be allowed where edge distances are less than 12 times the nominal diameter of the anchor stud.
3. Undercut bottom of hole using cutting tools manufactured for this purpose by the manufacturer of the undercut anchors being placed.

3.06 FIELD QUALITY CONTROL

A. Contractor shall provide quality control over the Work of this Section as specified in Section 01450 - Quality Control.
1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
1. Review anchor manufacturer’s installation instructions and requirements of the Evaluation Service Report (hereafter referred to as “installation documents”) for each anchor type and material.
2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner will provide on-site observation and field quality assurance for the Work of this Section.
1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to Engineer upon request.
   3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
      b. Concrete inserts (all types).
      c. Welded studs.
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
         3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
         4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
   3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
      a. Base material (concrete or grouted masonry):
         1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
         2) Material encapsulating embedment is dense and well-consolidated.

D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
      b. Sleeve anchors.
      c. Undercut concrete anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torqueing of anchors.
      a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.
   3. Requirements for periodic special inspection:
      a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for

the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new “initial inspection.”

b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor’s rated strength.

c. Anchor:
1) Manufacturer, type, and dimensions (diameter and length).
2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).

d. Hole:
1) Positioning: Spacing and edge distances.
2) Drill bit type and diameter.
3) Diameter, and depth.
4) Hole cleaned in accordance with manufacturer’s required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
5) Anchor’s minimum effective embedment.
6) Anchor tightening/installation torque.

4. Requirements for continuous special inspection:
a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
1. Owner may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.08 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations as specified using high strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.09 SCHEDULES

A. Stainless steel. Provide and install stainless steel anchors at the following locations:
1. “Corrosive locations” as defined in this Section: Type 316 stainless steel
2. “Wet and moist locations” as defined in this Section: Type 316 stainless steel.
3. “Other locations:”

a. For connecting stainless steel members to concrete or masonry: Type 304 stainless steel.
b. For connecting aluminum members to concrete or masonry.
c. For connecting fiber-reinforced plastic (FRP) members to concrete or masonry.

4. At locations indicated on the Drawings.

B. Galvanized: Provide and install galvanized carbon steel anchors at the following locations:
1. Locations not requiring stainless steel.
2. At locations indicated on the Drawings.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
1. Aluminum grating stair tread.
2. Aluminum stair nosing.
3. Cast iron stop plank grooves.
4. Concrete inserts.
5. Handrails and guardrails.
6. Ladders.
7. Manhole frames and covers.
8. Metal gratings.
9. Metal tread plate.
10. Preformed channel pipe supports.
11. Stairs.
12. Miscellaneous metals.
13. Associated accessories to the above items.

1.02 REFERENCES

A. Aluminum Association (AA):
1. DAF-45: Designations from Start to Finish.
a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):
1. Standard Specifications for Highway Bridges.

C. ASTM International (ASTM):
1. A36 - Standard Specification for Carbon Structural Steel.
2. A48 - Standard Specification for Gray Iron Castings.
3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications.
6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
7. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
9. A489 - Standard Specification for Carbon Steel Lifting Eyes.
10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

12. A635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
13. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. A992 - Standard Specification for Structural Steel Shapes.
15. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
20. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

D. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

E. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product Data:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Handrails and guardrails.
   5. Manhole frames and covers.
   6. Metal grating.

B. Shop drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.
      b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
      c. Include erection drawings, elevations, and details where applicable.
      d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Ladders.
   3. Metal grating.

4. Metal tread plate.
5. Stairs.
6. Miscellaneous metals.

C. Samples:
   1. Guardrails with specified finishes.

D. Quality control submittals:
   1. Design data.
   2. Test reports:
      a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current State and OSHA strength requirements.
      b. Gratings:
         1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
         2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

   1. Stainless steels are designated by type or series defined by ASTM.
   2. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MANUFACTURED UNITS

A. Aluminum grating stair tread:
   1. Manufacturers: One of the following or equal:
      a. Harsco Industrial IKG, Aluminum Grating Stair Tread with Mebac® nosing.
      b. McNichols Co., Type A-Standard with Corrugated Angle Nosing.
   2. Material: Welded aluminum grating tread with non-slip nosing and integral end plates for bolt on attachment to stair stringers.
   3. Size:
      a. Tread width: To equal tread spacing plus 1 inch minimum.
      b. Tread length: Length to suit stringer-to-stringer dimension on the Drawings.
      c. Depth: 1-3/4 inches.
   4. Bolts: Type 316 stainless steel.

B. Aluminum stair nosing:
   1. Manufacturers: One of the following or equal:
      a. Wooster Products, Inc., Type 101 Nosing.
      b. American Safety Tread Co., Inc., Style 801 Nosing.
   2. Material: Cast aluminum abrasive nosings with aluminum oxide granules integrally cast into metal, forming permanent, nonslip, long-wearing surface.

3. For installation in cast-in-place stairs.
4. Configuration: 4 inches wide, fabricated with integrally cast stainless steel anchors at approximately 12-inch centers. Length to extend within 3 inches of stair edge on each side.

C. Cast iron stop plank grooves:
   1. Manufacturers: One of the following or equal:
      a. Neenah Foundry Co., R-7500 Series, Type A.
      b. McKinley Iron Works, Type L.
   2. Size: 2-inch wide groove opening by 1-1/2 inches deep, unless otherwise indicated on the Drawings.
   3. Recess groove with the cast iron surface of the groove set flush with the concrete surface.

D. Concrete inserts:
   1. Concrete inserts for supporting pipe and other applications are specified in Section 15061 - Pipe Supports.

E. Handrails and guardrails:
   1. General:
      a. Design and fabricate assemblies to conform to current local, State, and OSHA standards and requirements.
      b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
         1) Indicate on the shop drawings locations of such equipment.
         2) Highlight locations where railings cannot be made continuous and obtain Engineer's directions on how to proceed before fabricating or installing railings.
   2. Aluminum handrails and guardrails (nonwelded pipe):
      a. Rails, posts, and fitting-assembly spacers:
         1) In accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
      b. Kick plates: 6061 or 6105 aluminum alloy.
      c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
      d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
         1) Fabrications: In accordance with ASTM B209 or ASTM B221 extruded bars:
            a) Bases: 6061 or 6063 extruded aluminum alloy.
         2) Plug screws or blind rivets: Type 305 stainless steel.
            a) Other parts: Type 300 series stainless steel.
      e. Finish of aluminum components:
         1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
         2) Pretreat aluminum for cleaning and removing markings before anodizing.
      f. Fabrication and assembly:
         1) Fabricate posts in single, unspliced pipe length.

2) Perform without welding.
3) Do not epoxy bond the parts.
4) Maximum clear opening between assembled railing components as indicated on the Drawings.

g. Manufacturers: One of the following or equal:
1) Moultrie Manufacturing Co., Wesrail.
2) Golden Railings, Riveted System.
3) Craneveyor Corp. Enerco Metals, C-V Rail.

3. Guardrail gates:
a. Supplied by guardrail manufacturer:
1) Of same material, quality, and workmanship as specified for guardrail system in which they will be installed.
2) Of design similar to that of handrail or railing system in which they will be installed.

b. Components: Gate frame, stainless steel self-closing device, hinges, gate stops, and durable self-locking type latch. Fabricate components in conformance with OSHA minimum strength requirements.

4. Fastenings and fasteners: As recommended or furnished by guardrail manufacturer for use with this system.

F. Ladders:
1. General:
a. Type: Safety type conforming to local, State, and OSHA standards as minimum. Furnish guards for ladder wells.
b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.

2. Aluminum ladders:
a. Materials: 6063-T5 aluminum alloy.
b. Rungs:
1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
2) Capable of withstanding 1,000-pound load without failure.

c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
d. Finish of aluminum components:
1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.

e. Fabrication:
1) Welded construction, of size, shape, location, and details indicated on the Drawings.
2) For ladders over 20 feet high, furnish standard ladder cages or fall prevention system designed in accordance with State and OSHA requirements.

f. Fall prevention system: Include but not limit to railing, brackets, clamps, 2 sleeves, and 2 belts, satisfying OSHA safe climbing requirements:
1) Manufacturers: One of the following or equal:
a) North Consumer Products, Saf-T-Climb.
b) Swager Communications, Climbers Buddy System.

G. Manhole frames and covers:
   1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
   2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
   3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
   4. Frame:
      a. Bottom flange type.
      b. Approximately 4-1/2 inches frame height.
      c. Dimensions as indicated on the Drawings.
         1) Minimum inside clear dimension may not be smaller than nominal diameter minus 2 inches.
   5. Cover:
      a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as "ELECTRICAL," "SEWER," "TELEPHONE," or "WATER."
      b. Solid type without ventilation holes.
   6. Finish: Unpainted.

H. Metal gratings:
   1. General:
      a. Fabricate grating to cover areas indicated on the Drawings.
      b. Unless otherwise indicated on the Drawings, grating over an opening shall cover entire opening.
      c. Make cutouts in grating where required for equipment access or protrusion, including valve operators or stems, and gate frames.
      d. Band ends of grating and edges of cutouts in grating:
         1) End banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
         2) Cutout banding: Full height of grating.
         3) Use banding of same material as grating.
         4) Panel layout: Enable installation and subsequent removal of grating around protrusions or piping.
         5) Openings 6 inches and larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
         6) Openings smaller than 6 inches: Locate opening at edge of single panel.
         7) Where an area requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4-points with fasteners acceptable to Engineer.
         8) Fabricate steel grating sections in units weighing not more than 50 pounds each.
         9) Fabricate aluminum grating sections in units of weighing not more than 50 pounds each.
         10) Gaps between adjacent grating sections shall not be more than the clear spacing between bearing bars.
      e. When requested by Engineer, test 1 section of each size grating for each span length involved on the job under full load:
         1) Furnish a suitable dial gauge for measuring deflections.
      f. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings.

2. Aluminum grating:
    a. Material for gratings, shelf angles, and rebates: 6061-T6 or 6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum alloy.
    b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
    c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
    d. Bar size and spacing: As determined by manufacturer to enable grating to support design load.
    e. Design live load: A minimum of 100 pounds per square foot uniform live load on entire grating area, but not less than the live load indicated on the Drawings for the area where grating is located.
    f. Maximum fiber stress for design load: 12,000 pounds per square inch.
    g. Maximum deflection due to design load: 1/240 of grating clear span.
    h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
    i. Minimum grating height: 1-1/2 inches.
    j. Manufacturers: The following or equal:
        1) Harsco Industrial IKG, Swaged Aluminum I-Bar with striated finish.

I. Preformed channel pipe supports:
    1. Preformed channel pipe supports for pipe supports and other applications are specified in Section 15062 - Preformed Channel Pipe Support System.

J. Stairs:
    1. Aluminum stairs:
        a. Stringers: 6061-T6 aluminum alloy.
        b. Stair treads:
            1) Aluminum of same type specified under Aluminum Grating.
            2) Of sizes indicated on the Drawings, and 1-3/4-inch minimum depth with cast abrasive type safety nosings.
        c. Handrails and guardrails: Aluminum pipe specified under Aluminum Handrails and Guardrails (Nonwelded Pipe).
        d. Fasteners: Type 304 or Type 316 stainless steel.

K. Miscellaneous aluminum:
    1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
    2. Do not weld or flame cut.

L. Miscellaneous cast iron:
    1. General:
        a. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
        b. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
        c. Before leaving the foundry, clean castings and apply 16-mil dry film thickness coating of coal-tar epoxy, unless otherwise specified or indicated on the Drawings.

M. Miscellaneous stainless steel:
    1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.

2. Cleaning and passivation:
    a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
    b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
    c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
        1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
    d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
        1) Passivation by citric acid treatment is not allowed.
            a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
        2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
        3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A380.
    e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A380.
    f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

N. Miscellaneous structural steel:
    1. Provide miscellaneous steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.

O. Isolating sleeves and washers:
    1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
    1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
    2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals.
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09960 - High Performance Coatings.
      c. Aluminum in contact with concrete or masonry.

B. Aluminum stair nosing:
   1. Install stair nosings on treads of concrete stairs, including top tread on upper concrete slab.
   2. Omit stair nosings where concrete is submerged.
   3. Cast stair nosings in fresh concrete, flush with tread and riser faces. Install nosing in center of step.

C. Cast iron stop plank grooves:
   1. Recess stop plank grooves with cast iron surfaces of groove set flush with concrete surface.

D. Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.
      b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint gap.
      c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
      d. Space attachment brackets as indicated in the manufacturer's instructions.
   2. Aluminum pipe handrails and guardrails:
      a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.
      b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.
      c. Discontinue handrails and guardrails at lighting fixtures.
      d. Provide 1/8-inch diameter weep hole at base of each post.
      e. Space posts as indicated on the Drawings.
      f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
      g. Space rails as indicated on the Drawings.

h. Make adequate provision for expansion and contraction of kick plates and rails.
    1) Make provisions for removable sections where indicated on the Drawings.
i. Make lower rails a single, unspliced length between posts, or continuous.
j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.
k. Draw up fasteners tight with hand wrench or screwdriver.
l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.
m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.
n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.
o. Replace damaged or disfigured handrails and guardrails with new.
p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.
    1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.
q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.

3. Guardrail gates:
    a. Install gate to be a vertical plane with the guardrail when in the closed position.
    b. Install hinges so that each gate can swing 180 degrees from the closed position to the fully open position.
    c. Install so that the gates swing to the walkway side of the guardrail only.
        1) Install gate stops on the stationary railing posts to prohibit gates from swinging in the wrong direction.
    d. Install gate frames, hinges, stops, and latches in conformance with OSHA minimum strength requirements.

E. Ladders:
1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
2. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.
3. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
4. Erect rail straight, level, plumb, and true to position indicated on the Drawings:
    a. Correct deviations from true line or grade which are visible to the eye.

F. Manhole frames and covers:
1. Installation: As specified in Section 02600 - Concrete Manholes.

G. Metal gratings:
1. General:
    a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.

b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.
d. Install angle stops at ends of grating.
e. Installed grating shall not slide out of rebate or off support.
f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
g. Top surfaces of grating sections adjacent to each other shall lie in same plane.

2. Aluminum grating:
   a. Aluminum grating: Support on aluminum shelf angles or rebates.
   b.

3. Heavy-duty steel grating:
   a. Support on hot-dip galvanized structural steel rebates embedded and anchored in concrete.
   b. Use for roadways, traffic areas, and where indicated on the Drawings.

H. Stairs:
   1. General:
      a. Install guard railings around stair wells as indicated on the Drawings or specified.

I. Stainless Steel:
   1. Welding:
      a. Passivate field-welded surfaces:
         1) Provide cleaning, pickling and passivating as specified in this Section.
         2) Clean using Derustit Stainless Steel Cleaner, or equal.

END OF SECTION